THE GLASS INDUSTRY

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A. C. S. MEETING AT TORONTO

Canadian setting attracts good attendance at the American Ceramic Society's forty-second annual meeting. Glass Division session leans heavily to the scientific. Candid camera shots of the glass men and a report of their doings follow.

Distance and the alarms of war proved no deterrent to the attendance at this year's annual meeting of the American Ceramic Society, which was held in Toronto, the week of April 8th. While registration fell somewhat short of Chicago's highpoint, the meeting ranked in size with many of the best. Student and feminine visitors, of whom some doubts had been held beforehand, boosted the registration figures substantially.

The Royal York Hotel proved an ideal convention home, and it is significant of the importance which this annual meeting has attained of late years that the largest hotel in the entire British Empire was taxed to capacity. And even the weather man was kind; though few could find much time from the full program to wander abroad through the streets of the city.

Highest praise to the entertainment committee for providing a program not only of marked excellence, but quite removed in character from the stereotyped pattern one has grown to expect. Both the Sunday night concert and the Pig and Whistle on Tuesday made it evident that Toronto is blest with a wealth of vocal talent, which it was a delight to hear.

The plant trip idea, which has been on the wane of late years, practically petered out at Toronto. Only one such project was undertaken—a visit to the nearby Lakefield quarries of Canadian Nepheline Limited, but even this had to be abandoned on account of the poor condition of the roads.

The Camera Club proved that full adolescence can be reached at a very tender age even in northern latitudes, for thus its second salon was most successful. It is evident that ceramists are as keenly interested in photography as in the sciences; though the high degree to which the photographic art has been brought makes it rank today almost as one of the sciences. Prize winning pictures are shown on another page of this number.

The Glass Division elected W. Ronald Lester of the Maryland Glass Corporation as its new chairman. Aaron K. Lyle of the Hartford-Empire Co. was advanced to the first vice-chairman, and W. C. Taylor, Corning Glass Works, joins the official family as second vice-chairman. Samuel R. Scholes continues to serve as the efficient secretary. New Committee chairmen are: F. C. Flint and W. M. Clark, Society Nominations; A. N. Finn, Division Nominations; A. K. Lyle and W. C. Taylor, Papers and Program; C. B. Delgado, Membership; G. W. Morey, Standards; N. W. Taylor, Research, A. S. Badger, Data; A. N. Finn, Rules; L. C. Roche and F. C. Flint, Councillors: R. Curts, Exhibition; and D. E. Sharp, Trustee.

Glassmen honored by the Society by being elevated to the grade of Fellow are Nelson W. Taylor, Pennsylvania State College and former Chairman of the Glass Division; J. Earl Frazier, Frazier-Simplex, Inc., R. R. Shivley, B. F. Drakenfeld Co., and John T. Ogden, Editor and Publisher of *The Glass Industry*.

Glass Division Luncheon

Committee C-14 met at the close of Tuesday's session with Dr. Morey in the chair. The several sub-committees reported some little progress in obtaining cooperating laboratories and in planning work to be presented at the "Substitute Congress," which will be held later in the year.

Dr. Hostetter read to Committee-14, and to other members of the Division who were present, a recent letter from Professor W. E. S. Turner in which a plan was described for having a "Substitute Congress" in England during June, 1940.

This will take the form of a meeting of the Society of Glass Technology, at which will be presented the papers prepared for the 3rd International Congress, originally planned for Berlin and Munich in 1939. The list will include those contributions from leading authorities who had been invited to give special lectures to the Congress in Germany. To quote Professor Turner: "These contributions, of course, would not be made in person, but would appear in print, and would be a token of International good will and evidence of desire to keep a measure of cooperation alive." The contribution invited from Americans were: "The Present Position of Our Knowledge of the Contributions of Glass based on X-Ray Examinations," by Professor B. E. Warren, and "The Softening Point of Glass," by Dr. J. T. Littleton or Dr. H. R. Lillie; and also a paper on the Electric Melting of Glass by Dr. Ferguson of Cleveland.

Among the special subjects calling for agreement in standards and specification is included "Proposed Method of Determining the Mechanical Strength of Glass," by a committee from the Glass Division of the Ceramic Society.

In view of the brief time remaining, and also conforming to a further suggestion by Professor Turner, it is likely that the American papers will be presented at the fall meeting of the Glass Division, this year.

At the Glass Division luncheon, on Wednesday, at which about seventy-five men were present, an unusual and sentimental note was struck by Dr. Frank W. Preston, who proposed several toasts. The first of these, which Dr. Preston and Chairman Taylor drank Scotch fashion,

standing with one foot in a chair and the other on the table, was to Dr. J. T. Littleton, whose amazing recovery from injuries in an automobile accident has been a cause for a general rejoicing. Dr. Preston recalled that at the meeting in Toronto, ten years ago, Dr. Littleton was chairman and that now he is the vice-president of the General Society and going strong. The second toast was to the memory of George W. Cooper, founder of THE GLASS INDUSTRY, and its editor when the 1930 meeting was reported. John Ogden, the present editor of this journal and Donald Sharp, who has made many important contributions to its pages, were called up, and all drank a second toast to the success of THE GLASS INDUSTRY. The secretary was commissioned to report the occasion to the surviving sister of Mr. Cooper.

Dr. Hostetter took the floor for some brief remarks concerning the Substitute Congress. He took the opportunity to say that when important toasts were drunk, in accordance with ancient custom and for the general good of the industry, the tumblers should be broken. Dr. Taylor did not miss his cue, and a very satisfying smash took place.

Institute of Ceramic Engineers

Most members of the Institute of Ceramic Engineers considered that the major outcome of their Toronto meeting was the adoption of rules which will tend to liberalize membership requirements. The by-laws had demanded that the full rank of Member could be obtained only by passing an examination, but that a professional engineering license was an equivalent. In practice, however, the use of the formal examination is said to be not very feasible.

The by-law changes adopted at Toronto place the responsibility for full investigation of the applicant's records with the Committee on Membership and Examinations, these records to be used as the basis for accepting Members. Under these new rules it is believed that many Associate Members have been made eligible for full Member grade.

The two sessions, Monday and Tuesday, were presided over by the retiring president, Prof. J. L. Carruthers, who is now succeeded by Harold G. Wolfram, vice-president of Porcelain Enamel and Manufacturing Co., Baltimore, Md. Other newly elected officers of the Institute include Edwin H. Fritz, manager Derry Works (electrical porcelain) of Westinghouse Electric and Manufacturing Co., vice-president; and Hobart M. Kraner, research engineer with Bethlehem Steel Company, secretary.

Glass Division Program

Throughout four half-day sessions, held rigidly to schedule by Chairman Nelson W. Taylor, reels of technical papers were unwound before the glassmen. In general, treatment was highly scientific, and subject-matters ranged from speculative notions concerning interatomic distances in the silica lattice, to the almost humdrum facts concerning the attack of water solutions on bottles.

The old reliable research firm, Finn & Co., National Bureau of Standards, contributed three papers. The absence of the authors was compensated by the presence of G. R. Shelton, of the Bureau, who read the papers in his initial—and very welcome—appearance before the Division. Specific refraction was the first theme. Young and Finn have made further advances in their attack upon the problem of estimating index of refraction from composition. Forty-seven oxides have capitulated, and the new positions are strongly held.

A second Bureau paper was by Donald Hubbard, on the expansibility of crystalline boric oxide. A year ago, one had doubts about the prospects of ever seeing any of this stuff. But now we are informed that its coefficient of linear expansion is 15×10^{-6}, very close to that of boron oxide glass, and that it collapses at 451° C., where the geophyiscal Laboratory said it had a melting point. Glaze and Finn showed how minute traces of coloring oxides, such as 0.001 per cent Ni O, might be detected in raw materials for optical and other fine glasses.

Hamilton, Hubbard, and Finn reported upon some umpiring that should be helpful to those who study solubility of glass. They find that aqueous extracts from most bottles may either be titrated by indicator methods, or may have their contents estimated by conductivity, with agreeing results. But the umpires warn against holding too strongly to results by only one method as telling the whole story of "solubility."

Camera users got some idea of what are available by way of refracting glasses and crystals for lenses, when G. W. Morey gave his summary on the refractive index of this and that. Dr. Morey's second paper was more exciting. It seems that the Geophysical Laboratory, in its quest for the truth about how Pluto worked in the bowels of the earth when the igneous rocks were formed, has progressed in the study of equilibria in silicate systems in water at 3000 lb. per sq. in. pressure and temperatures up to 1150° C. Glass compositions in the high-silica region of the devitrite field (at ordinary pressure) yield elegant two-pointed, quartz crystals at much lower liquidus temperatures, when the pressure is 200 atmospheres and the material is soaked in water (or is it steam?) above its critical temperature. A new pump capable of 20,000-lb. pressures, may permit still more interesting discoveries.

Alexander Silverman, University of Pittsburgh, gave an abstract of a lengthy report by Kuan-Han Sun on additive relationships between composition and the refractive index and density, or preferably specific volume, of glasses. This critical review of published data should be a useful addition to the literature of glass.

People who let their spectacles get dusty may not be all wrong; because C. Hawley Cartwright, of M. I. T., showed that a film of calcium fluoride four millionths of an inch thick reduces surface reflection and increases transmission of light through lenses. Slides showed comparative photographs taken through camera lenses, treated and untreated, and amazing improvements appeared. The movies will soon show Bill Robinson's freckles.

Nelson Taylor's proposal for cooperative research by the university laboratories for the glass industry, should appeal to companies who need to farm out their problems.

Iron is a great heat stopper in cold window glass; but R. L. Shute, reporting for Parmelee, Shute and Badger, University of Illinois, gave results indicating that heat penetrates more deeply into a tank of glass, when greater amounts of coloring oxides are present. This

J. R. Lester

surprising result met with some skepticism, but facts have a Finnish reputation.

When metals are heated with glass in a hydrogen atmosphere, some peculiar coloring effects are observed, according to Badger and Bard, University of Illinois. That new steel bottom for the tank had best be postponed.

The products of devitrification in glasses containing alumina and magnesia, as well as soda, lime, and silica, are quite different from those appearing in the simple soda-lime-silica glasses. This appears from the work of W. B. Silverman, Owens-Illinois Glass Co., whose phase-equilibrium studies have carried into the container-glass system. Another study of devitrification, by Greene and Morgan, Rutgers University, dealt with the soda-barytasilica system. No immediate commercial results were predicted for these findings. Similar remarks would apply to papers on electrical conductivity and dielectric constant of glasses. But we can never tell.

Under the leadership of B. E. Warren, M. I. T., further work has been done on the fine-structure of glasses. For the benefit of those who are curious, it is now demonstrated that the distance between the atoms in glass is rather less than 2 Angstrom units, or 0.000000008 inch. No wonder the stuff holds water! Warren's theoretical explanation of the imiscible liquids in the lime-silica system was a beautiful job.

The beauty of modern Grecian glassware was demonstrated by slides shown by Dr. Silverman, University of Pittsburgh. The ancients had a line which their descendants do well to copy.

E. L. Hettinger, Willson Products Co. showed that a fractured glass plate or lens serves as an excellent "negative" in his enlarging device.

Durability tests on optical glass are a new departure in experiments of this sort. F. L. Jones, Mellon Institute, showed some clever methods of checking laboratory against storage tests.

Bacon and Burch, of Owens-Illinois Glass Co., showed a closer approach to correlating accelerated tests on durability of bottles with actual results in use than has hitherto been reached.

All in all, the program was of great scientific interest. Translation of some of the findings into practical usefulness for the industry is another problem. It is, for example, small comfort to the finishing-room foreman to have Barstow of M. I. T. demonstrate by high-speed photography that glass never breaks faster than one mile per second, if the breakage rate is running up one per cent per week all over the shop. Summaries of the papers follow:

Specific Refraction of Glass and Glass Forming Materials. *By J. C. Young and A. N. Finn, National Bureau of Standards.*

Using the data on density and index of refraction found in the literature along some new data, the authors have made a study of various specific refraction ratios (R) in an attempt to find which ratio could best be expressed as an additive function of glass composition. It was found that the Gladstone-Dale ratio, $\frac{n-1}{d}$, was the most suitable of the seven ratios studied.

Data on about 600 glasses and 400 crystals was taken and Gladstone-Dale factors (r) calculated for forty-seven oxides as constituents of glass. These specific refraction factors (r) when plotted, by valence groups, against the serial numbers of the basic elements of the oxides were found to separate into two sub-groups which follow the familiar classification of the elements into the "long series" and the "short series". Regrouping the (r) factors with respect to item "A" or "B" classification after changing them into "unit—oxygen" values and then plotting the data, it was found that for the "B" elements that the values for each valence—group fell on a straight line, the intercept being common to all lines and the slope of the lines a simple function of the valency. The values for the "A"—elements did not yield this regular pattern and from an analysis of other data it was indicated that a variable oxygen factor for the "A" group elements must be assumed.

It was also shown that by the use of the specific refraction factor (r) it is possible to calculate the mu-values for boric, phosphoric and beryllium oxides indicate that these oxides should be useful in making glasses of very low dispersion.

Reducing the Reflection from Glass. *By C. Hawley Cartwright, Department of Physics, Massachusetts Institute of Technology.*

It has long been known that the tarnished surfaces of glasses of high refractive index such as are used in optical system diminished the reflection of light from the air-glass surface and thereby increases the light transmission of the lens system. Various methods have been devised in the past for artificially tarnishing glass, but the results were not sufficiently effective to warrant their commercial use.

It is now known that the tarnish is actually a film of transparent material having a lower index of refraction than that of the glass. To be most effective, such a film must fulfill specific requirements. For example, a homogeneous film that reduces reflection of green light to zero must satisfy two conditions, viz., (1) the index of refraction must be 1.23 and (2) its optical thickness must be 1370 A. The first condition is difficult to fulfill exactly, because it requires a film of an abnormally low index of refraction. Even when this condition is satisfied only approximately, however, a marked decrease in the reflection from glass is possible. The second requirement is of paramount importance. Although it may be fulfilled exactly for only one wave-length, the reflectance is greatly reduced throughout the spectral range used for most visual and photographic purposes. These two condi-

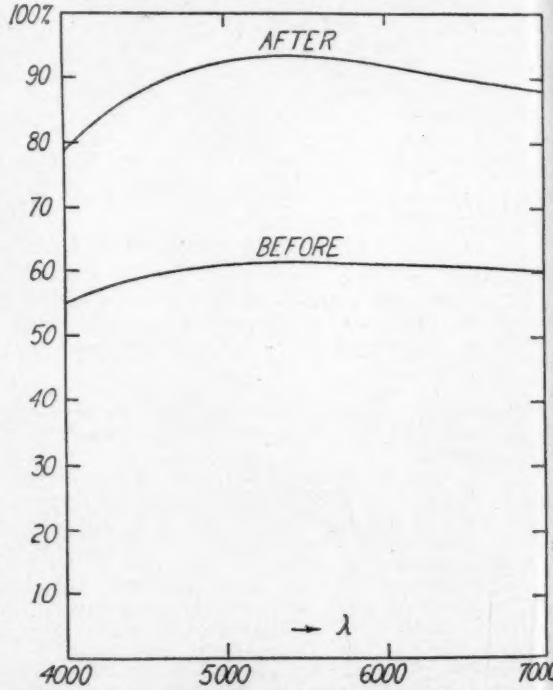


Fig. 1. Percentage transmission of the lens before and after being treated. (Schneider-Kreuznach Xenon *f*: 2, *F* = 5 cm.)

tions can be satisfied rather well by evaporated films of the metallic fluorides deposited on glass in vacuum.

In addition, some of the metallic fluorides can be hardened so that they will withstand weather and abrasion. The evaporation method, however, limits the use of the metallic fluorides to relatively small surfaces.

Reflection can also be reduced by a combination of films so applied that the sum of the three reflection vectors add to zero. Such films may consist of TiO_2 and SiO_2 and may be applied in air. Larger glass surfaces may be treated by this method.

The increase in light transmission after treatment of a camera lens system was illustrated (Fig. I) and comparison photographs taken before and after treatment were shown. The treatment of the lens doubled its efficiency and increases both the contrast and the detail.

Various applications of treated glass surfaces were also given and illustrated.

Rapid Methods for Detecting Small Amounts of Coloring Oxides in Some Batch Materials. *By F. W. Glaze and A. N. Finn, National Bureau of Standards.*

In optical glass manufacture freedom of coloring oxides in the raw materials is essential. Recently, objectionable amounts of coloring oxides in arsenic oxide and potassium carbonate have been found and while they were small in actual percentage the contamination of the glass was sufficient to materially reduce its total light transmission.

Methods for detecting amounts of nickel and cobalt oxide as low as 0.001 per cent in potassium carbonate and the oxides of arsenic, antimony and lead have been developed by the Bureau staff. In brief the procedures used depend upon colormetric methods; dimethyl glyoxime for nickel, alpha nitroso beta naphthol for cobalt and alkali periodate for manganese. Considerable attention is given to the preparation of the sample being analyzed.

Organization of Glass Research in Graduate Schools. *By Nelson W. Taylor, Chairman Glass Division,* 1939-40.

There is a rapidly increasing demand by progressive glass manufacturing companies for men who have had some graduate work in the fundamental sciences and who have acquired some knowledge of the properties of materials at high temperatures and some acquaintance with the technical and scientific literature on glass.

This kind of education can be best provided by those schools where glass researches are being prosecuted and where the requirements for the advanced degree include a substantial amount of fundamental science.

The present shortage of qualified men will continue unless some cooperative scheme is developed whereby promising bachelors of science are encouraged by scholarships or other subsidies to take further training with the object of making "Glass" their life work.

This serious problem is presented to the leaders of the glass industry for their consideration and action.

Effect of Certain Metallic Oxides on Rate of Heat Penetration of Molten Glass. *By C. W. Parmelee, R. L. Shute, and A. E. Badger, Department of Ceramic Engineering, University of Illinois.*

As practical experience indicates that colored or opaque glasses are easier to melt than colorless glass, the present study was undertaken in an effort to determine the basic reason for this fact.

The glasses used in this investigation were prepared by mixing a low iron plate glass with glasses containing iron, cobalt, and a combination of chromium and copper in such proportions so as to yield glasses containing 0.1, 0.3, 0.5, and 1 per cent of the coloring oxide.

The procedure used for the test on heat absorption was, in brief, as follows: The glass under test was placed in a pot furnace and heated by a gas burner until the temperature was stable at about 1340° C. A thermocouple was then dipped into the glass and the temperatures at points 1 cm. below the surface to 12 cm. below the surface were measured in 1 cm. steps. The data was presented in the form of curves which showed the temperature difference existing through the glass mass for the various glass colors and color densities.

The rate of fining was measured on a series of glasses containing iron oxide by the density method, the density of the glass being dependent upon the number of glass bubbles and seeds. The glasses were prepared by melting suitable batches at temperatures of 1200, 1275, and 1350° C. It was concluded that the greater ease of melting glasses containing colored oxides was due to (1) chemical action due to the fluxing properties of the oxide which results in a decreased viscosity at the melting temperature and (2) a physical action which results in the retention of a greater percentage of the heat which penetrates the glass at or near the surface of the melt. This action also reduces the viscosity of the glass. It was also shown that opaque glasses likewise possess the property of absorbing heat more rapidly than do colorless glasses.

Melting Rate of Soda-Lime-Silica Glasses as Influenced by Composition and Effect of Several Minor Constituents on Melting Rate of Such Glasses. *By J. C. Potts, Owens-Illinois Glass Co.*

In brief the procedure used in this investigation was as follows: small amounts of batch sufficient to yield about 5 grams of glass, were weighed up and thoroughly mixed for one-half hour. One tenth of the mixed batch was then placed in a small platinum crucible and placed in an electric furnace at a temperature of 2600° F. for an arbitrary period of time after which the melt was removed and when cold examined for the presence or absence of batch particles by the means of a low-power microscope. Repeated meltings allowed an estimate of the time required for the glass to become batch free to be made.

The base glass used had the following composition: 14 per cent Na_2O, 12 per cent CaO, 74 per cent SiO_2 ($+R_2O_3$). The effect of additions of borax, barium oxide, sodium sulphate, sodium nitrate, sodium chloride, ammonium sulphate and fluorspar on the melting time of this parent glass was investigated.

The results obtained allowed the following conclusions to be drawn: the substitution of soda or lime for silica in the parent glass materially decreases the melting time, soda being more effective than lime; the substitution of boric oxide for either soda, lime or silica first slightly decreases the melting time but in the case of substitution for soda or lime then increases the melting time. The minimum is obtained in the first case at about 0.25 per cent B_2O_3 and in the other at about 0.5 per cent B_2O_3. With barium oxide substitutions, when silica, lime or soda is replaced by amounts less than 2 per cent a minimum is obtained at about 0.5 per cent Ba O.

With the so-called "refining agents" it was found that the addition of small amounts of ammonium sulphate (less than 15 lbs. per ton of glass) or the substitution of part salt cake for soda ash (less than 70 lbs. per ton of glass) apparently decreases the melting time. With the substitution of either sodium chloride or sodium nitrate for part of the soda ash the melting time was increased. It was also concluded that fluorspar additions had a negligible effect.

Reaction Between Metals and Molten Glass. *By A. E. Badger and B. Bard, Department of Ceramic Engineering, University of Illinois.*

The reaction between metals and molten glass was studied by placing small amounts of the metal in the bottom of a crucible which was then filled with crushed bottle cullet. The crucible was then placed near the closed end of a gas tight porcelain tube which was inserted in an electric furnace. Hydrogen gas was circulated through the tube in order to prevent oxidation of the metal during the 2 hour heat treatment period at 1250° C. After removing the crucible, it was quickly cooled, broken open and the condition of the glass observed.

Copper, silver, gold and selenium gave the glass straw to reddish tints; carbon, sulphur and zirconium resulted in streaks of amber; barium and chromium gave dense black glasses while vanadium was similar except for an amber color at the top surface of the glass.

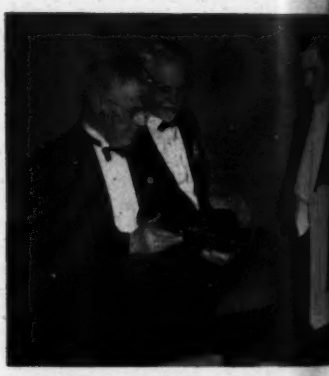
The Glass Division in session in the Ball Room of the Royal York Hotel, Toronto, during the forty-second annual meeting of the American Ceramic Society.

Vic Remington (Drakenfeld) examining photo submitted by Ceramic Camera Club members f second salon.

Time out for lunch—But time is precious at a busy convention, and the Glass Division makes use of the Wednesday noon hour to hold its business session.

The Chauncey E. Frazier Award Committee a labors. (Left to right) Francis C. Flint, Cha Spencer, and Prof. Joseph P. Thorley.

We won't disclose the mystery Prof. Montgomery (Toronto University) is about to reveal to (from the left) Dr. C. A. Taylor, E. Davis, and G. P. Cole (Dominion Glass), J. E. Ablard, Drakenfeld) and R. W. Greenwood (Dominion Glass).



E. L. Hettinger and Ross Purdy w MacDonald of the Toronto Cam specting the beautiful Frazier awa

Dick Carothers introducing his namesake, J. L., to Ross Purdy in the presence of McNeal (back to the camera).

Dr. G. W. Morey (seated) discussing refractive indices with Ralph K. Day.

Dr. Scholes of Alfred U with J. S. Owen of Ar Cork Co.

SNAPSHOTS OF THE TORONTO MEETING

Informal studies of the Glass Division members taken for The Glass Industry by J. Earl Frazier, E. L. Hettinger and Victor Remington.

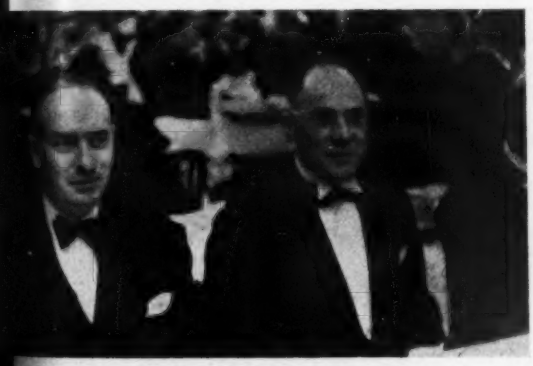
(Left) Dr. Nelson W. Taylor and Mrs. John Ogden at the Dinner Dance on Sunday night. While at another table (right) billowing fog enveloped Hostetter just as one of the members of the Camera Club snapped this photo.

The Camera Club Dinner, at which the prize winning pictures were announced. Frederick Carder, who designed the Chauncey E. Frazier award, is seated third from the left.

Mr. and Mrs. O. G. Burch of the Owens-Illinois Glass Co. at lunch in the Venetian Room.

J. Earl Frazier of Frazier-Simplex, Inc., and secretary-treasurer of the Ceramic Camera Club.

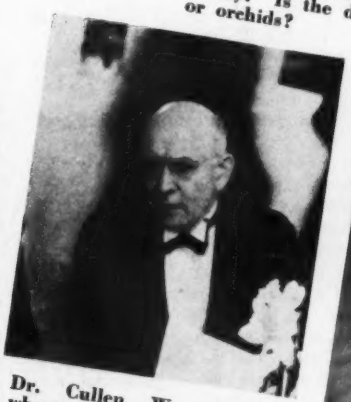
An unusual study of James Bailey (Hartford Empire Co.).



Aaron K. Lyle (left) and Donald Sharp of Hartford-Empire. Mr. Lyle was elected second vice chairman of the Glass Division.

Virgil Mullholland and Dr. George Morey. Is the discussion over boats or orchids?

Vic Remington and R. R. (Doc) Shively of Drakenfeld are trying to sell J. F. Green of Kimble the idea of applied color decoration on test tubes. Mr. Shively was advanced to the grade of Fellow by the Ceramic Society at Toronto.



Dr. Cullen W. Parmelee whose interest in the practical problems of the production man has been an outstanding contribution to the industry.

Dr. J. T. Littleton of Corning, whose return to health was acclaimed by members of the Glass Division at their luncheon.

With magnesium, calcium, titanium, manganese and aluminum, gray or black fogs with reddish gray areas near the top or sides of the crucible were noted. Silicon also produced a reddish gray fog, while iron and nickel produced greenish-yellow glasses. Cobalt caused a very faint blue with parts of the melt being reddish.

Fairly colorless glasses resulted from melts containing zinc, cadmium, bismuth, tin, lead, antimony, molybdium or tungsten.

An Isobar at 3000 Pounds in the System H_2O—Na_2O—CaO—SiO_2. *By G. W. Morey, Geophysical Laboratory.*

An apparatus has been developed which makes it possible to measure the effect of water at high pressure and temperature on the freezing point of silicate mixtures. At 3000 pounds pressure water dissolved in the melts of sodium silicates lower the melting point from 150 to 200° C.

With melts in the system, Na_2O—CaO—SiO_2 near the ternary eutectic, the freezing point was in some cases raised, in other, lowered. The raising of the freezing point probably is caused by an invasion of the field of devitrite by other fields, especially by that of quartz.

Effect of Alumina on Devitrification of Soda-Dolomite Lime-Silica Glasses. *By W. B. Silverman, Owens-Illinois Glass Co.*

By use of the temperature gradient method the effect of the substitution of 0 to 10 per cent Al_2O_3 for Na_2O, CaO. MsO or SiO_2 on the liquidus temperatures and phase relations of a series of glasses lying within the following composition range: Na_2O, 12-16%; CaO·MgO, O to 20%; and SiO_2, 63-78% was investigated.

From the results obtained it was concluded that in the compositional range studied dolomite containing glasses have lower liquidus temperatures than glasses containing equal percentages of calcite. When tridymite is the primary phase the replacement of SiO_2 by Na_2O, Al_2O_3 or CaO·MgO results in a lowering of the liquidus temperature. When diopside is the primary phase the replacement of CaO·MgO by SiO_2, Na_2O or Al_2O_3 lowers the liquidus temperature, however Al_2O_3 is the least effective of these substitutions.

The liquidus temperature is also lowered in the devitrite field when the CaO·MgO content of glass is lowered. Devitrite however is not a common primary phase in CaO·MgO glasses with soda contents below 16 per cent. It was also concluded that SiO_2 is more soluble in glasses containing CaO·MgO than in glasses containing CaO only.

The Effects of Lithia in Glass. *By C. W. Parmelee and Felix Fraulini, Department of Ceramic Engineering, University of Illinois.*

Four glasses were prepared from a good glass sand and chemically pure ingredients. The base glass had the composition:

	Per cent
Silica	73
Calcium oxide	12
Sodium oxide	15
Lithium oxide (was substituted for 5%, 10%, and 15% by weight of the soda)	

The mixtures were melted in platinum crucibles, cooled, crushed, and remelted.

Samples of these glasses were used for the determination of the following properties: thermal expansion, devitrification, indices of refraction, densities, surface tensions, rate of fining, and softening temperatures.

The interferometer was used for determining the thermal expansions. Within the range of 24°C to 200°C, the glass containing 5 per cent of lithia had approximately the same expansion as the base glass. An increase of lithia to 10 per cent was accompanied by a considerable increase in expansion. Further increase of lithia produced little change. In each mixture, the substitution of lithia increased the thermal expansion.

The devitrification studies were made on glass fibres heated in small furnaces so that there was a temperature gradient of 713° to 528°C in one series and 606° to 430°C in another series. In the first series, the heat treatment lasted for twenty-four hours. In the second series, the heat treatment lasted for one week. The devitrification products included devitrite, wollastonite, and an unidentified crystal species.

The introduction of lithia in increasing amounts definitely increases the tendency of the glass to devitrify.

The substitution of lithia for soda increased the indices of refraction from 1.525 for the base glass to 1.560 for that with the maximum lithia content.

The substitution of lithia in the base glass decreased the densities from 2.515 to 2.482.

The relative surface tensions of the glasses were determined at temperatures which permitted drops to form and detach themselves from glass fibres heated in a pointed flame. The substitution of lithia for soda decreased the surface tensions of the glasses.

The rates of fining of the several glasses were compared by melting batches in platinum crucibles at temperatures of 1000°C, 1100°C, and 1200°C. Since lithia is a more powerful flux than soda, glasses containing the former fined more rapidly than the base glass.

The relative softening temperatures were determined by the comparison of the temperatures of elongation of glass fibres at uniform and standard rates according to the method proposed by Littleton. A substitution of five per cent lithia produced a greater decrease of the softening temperature than was evident with the larger substitutions.

The System Sodium Disilicate—Barium Disilicate. *By K. T. Greene and W. R. Morgan, Dept. of Ceramics, Rutgers University.*

The sodium disilicate-barium disilicate join of the ternary system Na_2O—BaO—SiO_2 was studied by means of the quenching method and the phase equilibrium diagram determined. These two compounds form a binary system without intermediate compounds and without appreciable solid solution. The eutectic occurs at approximately 32 per cent barium disilicate by weight and at a temperature of 797° C. The melting point of barium disilicate was determined as 1418° C. The glasses in the field of stability of barium disilicate show a strong tendency toward devitrification.

The refractive indices of the glasses for sodium light were measured by the microscopic immersion method. These varied regularly from 1.505 for sodium disilicate glass to 1.610 for barium disilicate glass. The refractive index- composition curve plotted on a weight per cent basis is definitely convex downward, while on a mol per cent basis it is slightly convex upward.

Electrical Conductivity of Glass. *By A. E. Badger and J. F. White, Department of Ceramic Engineering, University of Illinois.*

A study of the electrical conductivity of glasses in the soda-lime-silica system and the changes in the electrical conductivity produced by equivalent additions of various oxides when incorporated in a parent soda-lime-silica glass was made. A frequency of 1000 cycles was used and the glasses measured at a temperature of 400°C. The relation between conductivity and temperature was not investigated.

From the data obtained it was shown that the resistance of the parent glass at 400°C. was increased by equivalent additions of SiO_2, Mn_2O_3, ZnO, B_2O_3, CaO, Fe_2O_3, BaO. PbO, TiO_2, and K_2O in that order while Na_2O and Al_2O_3 decreased it. (Fig. II)

The Effect of Composition and Heat Treatment on the Dielectric Constants of Soda-Borosilicate Glasses. *By J. M. Humphrys and W. R. Morgan, Dept. of Ceramics, Rutgers University.*

Two series of glasses were studied. In the first series, boric oxide was added in increments of 5 per cent up to 45 per cent to a base glass of the composition 18 per cent soda, 82 per cent silica. For these glasses both the density and dielectric constant showed a maximum at the composition for which the ratio of oxygen atoms to the sum of the boron and silicon atoms is 2.0.

In the second series of glasses, $Na_2O·B_2O_3$ was added to silica. For these glasses the density showed a maximum at 0.4 mole fraction $Na_2O·B_2O_3$, but the dielectric constant in-

creased continuously with addition of $Na_2O.B_2O_3$, the increase being nearly linear beyond 0.2 mole fraction $Na_2O.B_2O_3$.

The data were discussed in terms of the specific polarizations calculated by the Mosotti-Clausius and Lorenz-Lorentz equations. The total dielectric polarization was considered as the sum of two terms: the electronic polarization PE, and the atomic polarization PA.

The electronic polarization increased with:

(1) increasing concentration of oxygen atoms per gram of glass, and

(2) increasing concentration of singly-bonded oxygens.

The atomic polarization increased rapidly with increasing concentration of sodium ions, but was not zero for pure vitreous silica or for boric oxide.

The density increased, and the dielectric constant decreased continuously with decreasing temperature of stabilization. The effect of heat treatment was greatest for those glasses highest in soda, *i.e.* those with singly-bonded oxygens in the network. The glasses of the first series with an oxygen to boron plus silicon ratio near 2.0, and the glasses of the second series lowest in soda showed the smallest changes with heat treatment.

X-Ray Study of Potash-Silica, Lime-Phosphate and Lime Borate Glass. *By J. Biscoe, A. G. Pincus, C. S. Smith, M. Druesne and B. Warren, Department of Physics, Massachusetts Institute of Technology.*

X-ray diffraction studies were made of two samples of potash-silica glass of composition 20.9 and 29.1 per cent K_2O. A Fourier analysis of the intensity curves indicates a structure similar to that found in soda-silica glass. Each silicon is tetrahedrally bonded to four oxygen ions, with each oxygen bonded to either one or two silicons. The potassium ions K^+ are situated in holes in the silicon-oxygen network and have on the average about ten oxygen neighbors. Electrical conduction in a potash-silica glass takes place by migration of the K^+ ion through the holes and channels in the silicon-oxygen network. The process is similar to that for a soda-silicon glass, except that the K^+ ion is appreciably larger than the Na^+ ion, and would therefore be expected to migrate through the holes in the silicon-oxygen network with greater difficulty.

X-ray studies were made of two samples of lime phosphate glass with compositions 23 and 28 per cent CaO. Fourier analyses of the intensity curves were made in the usual way. The results indicate that each phosphorus atom is bonded tetrahedrally to 4 oxygen atoms at a distance of 1.57A, and each oxygen is bonded to either one or two phosphorus atoms. The Ca^{++} ions are in the network holes with about seven oxygen neighbors. The structure is similar to that of a lime-silica glass except that the number of single bonded oxygens is higher.

A lime-borate glass of composition 25 per cent CaO was studied in the usual way. The position of the first peak in the Fourier curve indicates that part of the borons are bonded to three oxygens and part to four oxygens. The Ca^{++} ions are randomly arranged in holes in the boron-oxygen network.

On the silicate, phosphate and borate glasses the essential feature of the glass structure is the same. The glass forming cations Si, P, B, B form a random network with the oxygen atoms, the Si and P atoms being tetrahedrally bonded to four oxygens, and the boron bonded partly to three and partly to four oxygens. The secondary cations such as K^+ or Ca^{++} are situated in network holes.

Atomic Consideration of Ommiscibility in Glass Systems. *By B. E. Warren and A. G. Pincus. Department of Physics, Massachusetts Institute of Technology.*

An attempt is made to apply the ideas crystal chemistry to the problem of immiscibility in glass systems. Miscibility is favored by the tendency of the network forming cations Si, B, P to bond with all available oxygens in the melt. Immiscibility is favored in compositions which do not allow the other cations such as Na^+ $Ca^{++}$to be properly surrounded by unsaturated oxygens. On a soda-silica or lime-silica glass each silicon is tetrahedrally bonded to four oxygens. Since the oxygen-silicon ratio is greater than 2, part of the oxygens are bonded to two silicons and part only to one silicon. The single bonded oxygens are unsaturated, and the secondary cations such as Na^+ and Ca^{++} try to surround themselves by a suitable number of unsaturated oxygens. Of the alkali or alkaline earth content is small, and the atoms are uniformly dispersed through the melt, it is impossible for a Na^+ or Ca^{++} ion to be surrounded by a proper number of unsaturated oxygens. There is therefore a tendency for segregation of a phase of higher alkali on alkaline earth content in which the secondary cations will have more unsaturated oxygen neighbors. On a soda-silica melt since the sodium ion is monovalent, the Na-O bond energy is relatively low, and the providing of suitable surroundings for the Na^+ ion is not very important. The tendency of the silicon ion to bond with all the available oxygen in the melt outweighs the desire for the Na^+ ion to be properly surrounded, and accordingly soda and silica are completely miscible.

On a lime-silica melt conditions are different. The Ca^{++} ion is divalent, and the Ca-O bond energy becomes important. The melt is unstable unless the Ca^{++} ions can be properly surrounded by unsaturated oxygens, and for low lime content this is accomplished by segregation of a phase of higher lime content. From geometrical considerations one can calculate the smallest lime-silica ration which will provide suitable surroundings for the Ca^{++} ions. The value comes out 33 per cent CaO by weight as compared with the experimentally determined limit of immiscibility 28 per cent.

The miscibility of lime in silica is increased by the addition of very small amounts of certain constituents. The effect seems to be one of adding something which itself is soluble in silica, and which produces unsaturated oxygens. From this point of view one can understand why the addition of small amounts of Na_2O or Al_2O_3 will increase the miscibility of lime in silica, whereas a small addition of B_2O_3, does not have the same effect.

Some Observations on the Thermal Expansion and Melting Point of Crystalline Boric Oxide. *By Donald Hubbard, National Bureau of Standards.*

As the published data on the expansion of fused B_2O_3 glass is very conflicting and as it was desired to know some of the characteristics of the B_2O_3 expansion curve, the following study was made:

The expansion was determined by the interferometer method on a sample of B_2O_3 glass prepared by heating H_3BO_3 at 1050°C. The initial expansion curve on air quenched samples was given and it was shown that the curve had two regions of negative expansion, one at 150°C and a more pronounced one at 260°C, the latter being converted to a larger positive expansion and the former persisting although altered in position and magnitude on the re-run. A series of determinations were then made which indicated that the negative expansion at about 150°C could be attributed to the presence of water.

The same negative expansion was found in the case of a sample of crystalline B_2O_3. A value of 450.8°C was obtained for the melting point of this sample. This value is in good agreement with the 450± 2°C melting point found by Kracek, Morey, and Merwin, but the author suggested that his value might be low due to the presence of water. The lower melting point, *i.e.*, 294°C found by Cole and Taylor by the differential thermocouple method was shown to be close to the point at which the maximum endothermic reaction accompanying the rapid expansion of fused B_2O_3 takes place.

Modern Grecian Glassware. *By Alexander Silverman, Department of Chemistry, University of Pittsburgh.*

This paper is devoted to the history of the chemical and glass syndicate of Greece, which probably has the largest capital investment of any organization of its type in the Near East. This corporation has employed artists who have developed unusual modern designs in glass, based on some of the ancient Egyptian, Roman, and Grecian designs. A paper of this same title appeared in the January issue of THE GLASS INDUSTRY.

Fracture Studies by Direct Photographic Enlargement. *By E. L. Hettinger, Willson Products, Inc.*

Photographic enlargements lens blanks having different types of fractures were shown. The prints were made by a direct process using a Sunray enlarger which took a 4 x 5 negative. The fractured glass sample was placed in the negative holder and projected directly upon Kodabrom paper, the exposure time depending upon the type of lens used. By placing a polarizing medium over the top of the negative carrier and one below the lens system it was possible to photograph the strain patterns surrounding the fractures.

Durability of Optical Glass. *By Frank L. Jones, Mellon Institute.*

Samples of polished optical glass were exposed under various conditions and the optical systems of instruments in use and in storage were studied. Two general types of change in the polished surface were noted in the cases where weathering had taken place. Glass that remained in a humid atmosphere for a long period of time became covered with a hazy film of soluble alkaline salts. All glasses are subject to such dimming in contact with water vapor, the rate and degree of dimming varying with different glasses. The second type of weathering is the formation of transparent silica-rich surface films because of the loss of high-refractive index oxides such as lead or barium from the surface of the glass by solution in water. A filmed glass is usually not harmed in any way, but interference effects make the surface appear colored so that the user considers it stained.

A study of published durability tests led to the adoption of a stain test similar to that of Berger. A new dimming test was developed in which glass samples are exposed to a saturated humidity atmosphere for 28 days at 50°C. and then compared with standard ground glass samples.

Optical glass made in the United States and in three other nations was compared by laboratory tests and by exposure tests in this country and in the tropics. Domestic optical glass compared well with that made abroad. The correlation between laboratory results and the action of the glass in the exposure tests was good.

The stain test and the dimming test have been used to study the effects of plant processes on glass durability. Test results have been employed as a guide in the selection of the proper glasses for instruments dsigned for specific uses. Laboratory comparisons of the stain resistance and dimming rate of experimental glass melts have also indicated the effects of composition changes on durability.

Effect of Time and Temperature on Accelerated Chemical Durability Tests Made on Commercial Glass Bottles, Part II. *By F. R. Bacon and O. G. Burch, Owens-Illinois Glass Co.*

The chemical resistance of eleven different compositions of 4 oz. glass containers which had previously been determined by the means of various accelerated tests was compared with the results obtained by room temperature storage test. After analyzing the data, the authors concluded that: (1) The resistances of glass to acidic solutions, to neutral and unbuffered solutions, and to initially alkaline solutions are independent of one another and must be tested separately. (2) The American Ceramic Society Tentative Method No. 1 (crushed sample test with acid) gives results which may be interpreted in terms of the relative resistances of unweathered bottls of like sizes and shapes to acidic products at room temperature. (3) Accelerated bottle surface tests with dilute acid may be interpreted in terms of the relative resistance of various kinds of bottles to acidic products at room temperature, if each kind of bottle tested has the same size, shape, and storage history as the corresponding bottles being considered for room temperature service. (4) Tests conducted with distilled water measure the resistance of glasses to solutions constantly increasing in alkali content. The rate of increase of alkali content of the solution is dependent on the glass composition. Such tests are related only to the resistance of glass bottles to neutral, unbuffered solutions. (5) Relative resistances of glass bottles to extraction of alkali, as shown by test with distilled water at an elevated temperature, roughly parallel the relative resistances appearing in the storage of distilled water at room temperature, only if the amounts of extracted material are approximately the same at both temperatures. (6) The tendency of bottles to produce flakes in distilled water under given conditions must be considered as a probability. Only rough tests can be made, unless a considerable number of each kind of bottle are subjected to identical conditions. (7) There is no relation that holds for all glass bottle compositions between the tendency of a bottle to form flakes when filled with distilled water or with an alkaline solution and the amount of soluble material extracted from the glass surface by distilled water or by such an alkaline solution. (8) The most suitable method of comparing the resistances of glass bottles to the action of an alkaline product such as N/50 sodium hydroxide is the direct observation of the apparent quantities of insoluble matter produced on storage of the product.

A Comparison of Titration and Conductivity Methods for Determining the Relative Solubility of Glass. *By E. H. Hamilton, Donald K. Hubbard and A. N. Finn, National Bureau of Standards.*

The usual method of expressing the chemical durability of glass containers is to state the degree of alkalinity of the extract obtained when the bottle is filled with an attacking medium and subjected to definite time and temperature conditions. The degree of alkalinity is usually determined by titration of the bottle extract using methyl red as the indicator. As it is well known that the presence of carbon dioxide affects the methyl red end point other indicators have been studied to order to see if one could be found that would be more suitable for this purpose.

In the first part of this present investigation the alkalinity of filtered aqueous extracts from glass bottles was measured potentiometrically, by direct titration and by back titration. Several different indicators were used, namely: phenolphthalein, phenol red, brom thymol blue, methyl red, chlor phenol red, para nitrol phenol and methyl orange. The results obtained showed that "back titrations" are more reliable than direct titrations and that methyl orange and phenolphthalein are the most unsatisfactory of the indicators used. In the case of methyl red, this indicator was found to be satisfactory for titration but in the case of direct titration the titration should be continued until the addition of one drop of acid produces a deep red which persists after stirring for 15 to 30 seconds.

The relationship between the alkalinity and the conductivity of the extracts was then determined in order to see if the alkalinity of the extract was an actual measure of the attack on the bottle. Bottle extracts were prepared from thirteen different types of bottles and then alkalinites and conductivities determined. The data was given in the form of graphs obtained by plotting the alkalinity against the conductivity.

In the case of direct titration on unfiltered extracts the plot resulted in a straight line which did not pass through zero indicating that the conductivity of the solution is not directly proportional to its concentration. In the case of back titration on filtered extracts the plot did pass through zero thus indicating that the back titrations gave results closer to the absolute alkalinity of the extract. When the back titrations on unfiltered extracts were plotted against the conductivities, the points were so scattered that three straight lines could be drawn indicating that flakes contribute to the back titration but not to the direct titration or conductivity. In all three cases three of the thirteen bottles did not fall on the straight line, their conductivities being much greater than normal.

It was concluded that in future studies on the chemical durability of glass containers factors other than the alkalinity of the extracts must be considered and it was suggested that in future work that analyses of the bottle extracts for their SiO_2, CaO, MgO and Na_2O content be made and that the amount of flakes present be determined, as such information might yield desirable information from a technical viewpoint.

Cast Alumina Refractories and Their Use in the Glass Industry. *By A. A. Turner and H. N. Baumann, The Carborundum Company.*

Before work was begun on the development of cast alumina refractories a study of the mechanism of attack and failure

of the commonly used refractories was first made. New and used blocks were studied both from a physical and a petrographical standpoint and glass-refractory reactions were studied by means of the thermal microscope. These preliminary studies indicated that a block having a high alumina content with little or no silica, and physical properties which would eliminate continuity of pore structure, eliminate less refractory bonds, and which would insure interlocking of the grog or crystalline particles would be highly resistant to glass attack.

Working along these lines, small test pieces were first cast and tested in a small continuous glass tank, using various glass compositions. In this manner unsatisfactory block compositions were quickly eliminated. Larger blocks of satisfactory composition were then cast and used in a larger glass furnace under actual operating conditions. From the results of this work it was found that no one block composition could be successfully used for all locations in a glass furnace, and as a result three different block compositions have been developed and are referred to as Monofrax H, K, and L.

Monofrax H consists chiefly of beta alumina crystals packed very closely together and is almost free of matrix. This composition is especially free of glass coloring oxides and the block is free of pipes, although it has a few pores. Its exceptional purity recommends it for furnaces producing high grade crystal glassware. It is also being used for bridge wall and throat blocks.

Monofrax K consists of alpha alumina in a matrix of what may be chiefly chromite containing spinel. Tests have showed that its rate of corrosion is so slow that the effect of its iron and chromium content is negligible. Glass produced in a tank constructed with this block had a Cr content of .0008%. The block is free of pipes but does contain some sealed pores. As it is the most corrosive resistant of the three compositions it is recommended for the doghouse position and the side walls in the melting end of glass furnaces.

Monofrax L consists of crystalline alumina (the primary phase being alpha alumina) modified by the presence of titanium and alkaline earth oxides. The block is free of pores but sometimes shows a pipe near one face of the block. Monofrax L can be used both in the melting and the refining end of the furnace.

Some of the physical properties of these three blocks are shown in Table I.

TABLE I

	H	*K*	*L*
Conductivity, c.g.s. units 350-850°C	.0059	.0107	.0137
Coeff. of Expansion x 10^6 25-750°C	5.69	—	7.00
25-1400°C	7.44	9.33	8.79
Spalling Test No. of Cycles	40	3	33
Pounds per cu. ft.	180	205	201

The Refractive Indices of Various Substances. *By G. W. Morey, Geophysical Laboratory.*

Improvement in lens design, especially of the high-speed types in great demand, is dependent on glasses having both high refractive index and smaller dispersion. The glasses which are available at present show a considerable range in these properties, but it is of interest to compare glasses with other materials. The refractive index nd and the nu-value [(nd—1) / (nf—nc)] of all the commercial optical glasses and of over 70 other substances, including isotropic crystals ranging from the diamond, zinc sulphide, to the fluorides, and liquids, ranging from bromine, iron carbonyl, organic liquids and water, were compared. It was shown that the glasses occupy a unique position, in general being less dispersive than other substances. This is due largely to the effect of silica, which is itself noteworthy for its small dispersion. Some newly developed glasses show even greater departures from the conventional types in the direction of higher refractive index and smaller dispersion than any types available commercially.

The Relation of Density and Refractive Index to the Composition of Glass. *By Kuan-Han Sun and Alexander Silverman, Department of Chemistry, University of Pittsburgh.*

As this paper was very lengthy, being over one hundred pages and containing nearly 110 references, Dr. Silverman very briefly discussed the subject matter and its method of treatment.

The junior author has reviewed all of the existing literature on this subject and has summed up our present knowledge regarding the relation between density, refractive index and glass composition. The possibility of future work and the direction it should take is also discussed.

MEETING OF PETROGRAPHERS

A meeting of petrographers and microscopists working in the cement and ceramic industries has been arranged to be held at the National Bureau of Standards, Washington, D. C., May 2-4, 1940.

This meeting will serve primarily to bring workers together in an informal way to discuss principally difficulties in technique that are encountered daily.

The petrographic laboratories of the Bureau's Division of Clay and Silicate Products, including the laboratories of the Portland Cement Association's Research Associates at the Bureau, will be available so that technical novelties and technique can be demonstrated.

Mr. Herbert Insley, of the Bureau of Standards, is chairman of the meeting.

GLASS CONFERENCE MAY 10 AT URBANA

The Sixth Conference on Glass Problems will be held on May 10 and 11, in Urbana, Illinois. The conferences, which are sponsored by the Department of Ceramic Engineering of the University of Illinois and the Chicago Section of the American Ceramic Society, are designed to promote an interchange of ideas among men engaged in the practical operation of glass plants. One of the most valuable features of the conferences is the informal discussion which follows the delivery of each paper, in which the audience always takes an active and enthusiastic part.

Sessions will be held in Room 218 of the Ceramics Building. Friday evening the conference will meet for dinner, following which Professor C. F. Hottes of the Natural History Department will give an illustrated lecture, on a subject to be announced later.

The tentative program follows. Copies of the final program will be sent, when completed, to anyone requesting them. Address inquiries to C. W. Parmelee, Head, Department of Ceramic Engineering, University of Illinois, Urbana, Illinois.

Friday Afternoon, 1:30 p.m.

A Short Report of Departmental Research.

Chemical Durability of Glassware from the Distillers' Standpoint, by A. Herman, Seagrams, Inc.

Binding of Glass Batch, by R. L. Shute, the Department of Ceramic Engineering.

Use of the Employees' "SUGGESTION BOX", a discussion to be led by W. S. Kahlson, Pitney Glass Works of the General Electric Company.

Saturday Morning, 9 a.m.

Monday Morning Start-up, (furnace conditions resulting from the week-end shut-down), by W. J. Mathews, Lapel, Ind.

Controlled Tank-Pressure and Combustion, by I. G. Fowler, Libbey-Owens-Ford Glass Company.

Progress Report on Glass Molds, by W. H. Bruckner, Department of Metallurgy.

Modern Plastics, (illustrated lecture) by F. W. Warner, General Electric Company.

REMMEY WINS FRAZIER AWARD

The Chauncey E. Frazier Award of Merit of The American Ceramic Society was presented to G. Bickley Remmey of The R. C. Remmey Son Company of Philadelphia in absentia at the Annual Dinner Meeting of The Ceramic Camera Club in The Royal York Hotel in Toronto, Canada on Wednesday evening, April 10.

E. L. Hettinger, director of research of Willson Products, Inc. introduced Dr. Ross C. Purdy, general secretary of the Society as Toastmaster. Dr. Purdy introduced Professor Joseph P. Thorley, head of the Department of Ceramics and Art of The University of Pittsburgh who made the formal presentation.

Professor Thorley in his presentation said, "the quality of the photographic art exhibited at this second annual salon of The Ceramic Camera Club is so excellent that the task of selecting the most outstanding photograph by the Jury of Award was very difficult. Mr. Remmey's photograph titled "Pussy Willow" and entered in the pictorial classification has won the unanimous approval of the judges, composed of Francis C. Flint of the Hazel-Atlas Glass Company; Charles D. Spencer of the General Electric Company and myself. I express the wishes of the Jury of Award that in future years there be a greater number of photographs exhibited showing industrial and scientific studies of ceramics and glass which also is the hope of the donors of The Chauncey E. Frazier Award.

"I extol some of the international achievements of Mr. Frazier, in glass plant engineering, professional engineer, and Fellow of The American Ceramic Society, also of my pleasure in knowing that Mr. Frazier has recently been honored by The Society of Glass Technology of England in the raising of him to the rank of Fellow. I am familiar with the excellent work and it is my pleasure to know the artist and craftsman, Frederick Carder, art director of the Steuben Division of The Corning Glass Works who has designed and made this beautifully engraved Steuben glass trophy. I know many of my friends and acquaintances would willingly relinguish other aesthetic honors and plaques for the privilege of winning something created by Frederick Carder. It is a very great pleasure to bestow this beautiful award to Mr. Remmey for his fine contribution."

Dr. Purdy next presented Randolph Macdonald, immediate past president of The Toronto Camera Club, who is an Associate of The Royal Photographic Society of England. Mr. Macdonald was one of the Committee of three Toronto photographic craftsmen who judged the Ceramic Camera Club's second annual salon and awarded the classification ribbons. The other members of this committee were W. H. Hammond and Stanley Harrod.

Mr. Macdonald in his talk also praised the quality of the salon and offered congratulations. He expressed pleasure in having been able through The Toronto Camera Club, to sponsor the exhibit. He criticized and told how to improve a dozen prints of pictorial and portrait classifications that were hung in the salon. He expressed the hope that members of The Ceramic Camera Club would exhibit prints in the Toronto salon this year.

Dr. Purdy next introduced W. H. Hammond of Toronto; Frederick Carder of Corning; and Gordon C. Keith, general secretary of The Canadian Ceramic Society. A business meeting followed.

The Board of Governors of the Ceramic Camera Club were reelected as follows: John M. McKinley, North American Refractories Co., (chairman); J. Earl Frazier, Frazier-Simplex, Inc. (secretary-treasurer); John R. Hostetter, *The Glass Industry;* Irwin W. Schoeninger, Globe-Union, Inc; and E. L. Hettinger, Willson Products, Inc.

The winners of the awards in the different classifications are:

Pictorial: First Prize, "Deserted," Rolland Roup.
Honorable Mention, "Pussy Willow," G. Bickley Remmey.

Action: First Prize, "W&J—Waynesburg Basketball Game," J. Earl Frazier.
Honorable Mention, "Skyward," Rolland Roup.

Portrait: First Prize, "Yum Yum," Roy W. Wampler.
Honorable Mention, "Yas Suh! This Was The Senator's Hat," John M. McKinley.

Trade Paper: First Prize, "Decline of the West," Robert C. Knauft.

Industrial: First Prize, "Sparks," Lewis M. Austin.
Honorable Mention, "Rhythm in Industry," J. Earl Frazier.

Scientific: First Prize, "Science-Polarized," E. L. Hettinger.
Honorable Mention, "Double Refraction Polarized," E. L. Hettinger.

GLASS MEN IN TRAIN WRECK

Several men who are associated with the glass industry were in the Lake Shore Limited when that train was wrecked at Little Falls, New York, just before midnight on April 19.

Arthur McKinley Greaves-Walker, assistant to the chief technical engineer of the Libbey-Owens-Ford Glass Company, and a recognized authority on ceramics, was fatally injured when the car he was riding in was unroofed by the impact.

His body was recovered from the wreckage of the train by rescue workers some 36 hours later. He is survived by his wife and two-year old daughter, and parents, Dr. and Mrs. Arthur Greaves-Walker. The father is well known to the ceramic industry and is professor of ceramic engineering at the University of North Carolina.

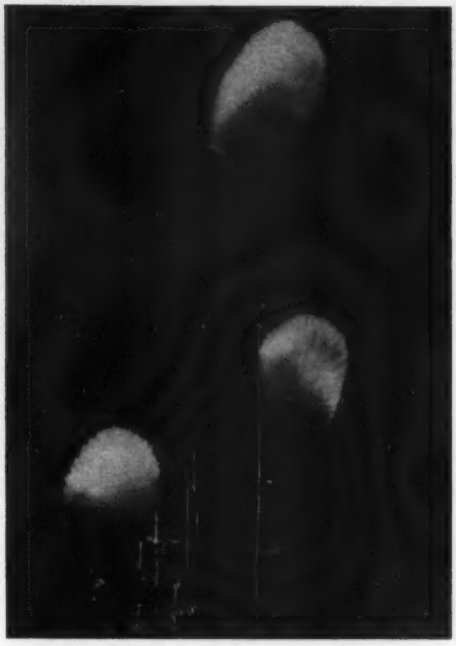
Among the many others known to the glass industry who were homeward bound are as follows: J. Preston Levis, Randolph H. Barnard, William M. Robertson, George S. Babcock and H. S. Wandling, all of the Owens-Illinois Glass Company; Jan S. Irvine and W. R. Sykes of the Owens-Corning Fiberglas Company; and Albert S. Zopfi, division manager of the Laclede-Christy Clay Products Company. None of these men were seriously injured and all were able to resume their duties.

Mr. Zopfi, who was in the same car with Mr. Greaves-Walker, escaped miraculously from death. He had been with Mr. Greaves-Walker a few minutes before, and had intended to resume their talk, when the crash came. The occupant of the berth above him, the man in the berth at his feet, and the man in the berth opposite him were all killed.

The survivors praised the efficiency of the train crew and the comparative calmness of the passengers during the ensuing hours.

PRIZE WINNING PICTURES AT THE CAMERA CLUB SALON

(Left) The Chauncey E. Frazier Award for photographic excellence in the ceramic arts, which has been instituted by the Frazier Family in honor of their father. The Plaque is of glass and was designed by Frederick Carder and executed by Steuben.



Pictorial: Honorable Mention and Frazier Award Winner, "Pussy Willow." By G. Bickley Remmey.

Scientific: First Prize, "Science—Polarized." By E. L. Hettinger. Showing that a print can be made by direct projection without a negative.

Scientific: Honorable Mention, "Double Refraction Polarized." By E. L. Hettinger.

...rial: Honorable Mention, "Rhythm ...dustry." By J. Earl Frazier. (Mr. ...r waited 5 years to get this view.)

Pictorial: First Prize, "Deserted." By Rolland Roup.

Trade Paper: First Prize, "Decline of the West." By Robert C. Knauft. (But where are the Trade Papers?—Ed.)

Action: First Prize, "W & J-Waynesburg Basketball Game." By J. Earl Frazier.

Industrial: First Prize, "Sparks." By Lewis M. Austin.

Action: Honorable Mention, "Skyward." By Rolland Roup.

Portrait: "Yas Suh! This Was the Senator's Hat." By J. M. McKinley.

Portrait: First Prize, "Yum, Yum." By Roy W. Wampler.

W.P.A. AND STATE OF NEW JERSEY START GLASS WORKS AT MILLVILLE

A new glass-making enterprise is being organized at Millville, N. J., under the sponsorship of the New Jersey Department of Conservation and Development in cooperation with the Federal Works Projects Administration. Its purpose is to provide employment for skilled glass workers of that community, of whom there are said to be approximately 150 on relief or working at pick and shovel jobs. Inquiry by THE GLASS INDUSTRY at W. P. A. headquarters in Newark, N. J., discloses that the enterprise will be housed in an old, abandoned plant in Millville that has been idle for many years. A single furnace will be built, with six pots, though it is not expected that all of the six pots will be used immediately. Hand blown ware and art glass will be produced for state institutions, including sculptured products. The State of New Jersey will furnish the materials and pay the rent, labor being provided by the W. P. A. Operations are expected to start in May.

RUTGERS CERAMIC EXPOSITION

The Fifth Ceramic Exposition of the Department of Ceramics, Rutgers University, will be held at the Ceramics Building from May 6th to May 12th. The previous Expositions were held in 1929, 1931, 1933, and 1936. As in the past, this Exposition will be widely advertised and will be open to the public without charge. It is hoped to exceed the 1936 attendance record of over 10,000 visitors.

The purpose of these Expositions has been two-fold: To acquaint the general public with the scope of the ceramic industry and particularly as to the extent and diversity of the industry in New Jersey; To acquaint young men, particularly high school students, with the possibilities in the field of ceramic technology as a career.

Manufacturers of ceramic products are asked to send exhibits of their wares for display at the Exposition; the exhibits being so selected as to illustrate the recent developments in the various branches of the industry. At the Fourth Ceramic Exposition, 75 corporations had their wares on display and we anticipate fully as many exhibits at the Fifth Exposition.

THOMAS McBRIDE DIES

Thomas McBride, president of the McBride Glass Co., Salem, West Va., died on April 24 in Los Angeles, at the age of 78. Mr. McBride was one of the well-known pioneers of the glass industry. From a humble beginning as a glass chimney blower at Jeannette, Pa., he climbed the ladder until in 1903 he founded his own company, the McBride Glass Co., at Salem, W. Va. At one time he operated a plant at Anaheim, California, and later another plant at Shreveport, La. Today his company at Salem has two factories in operation. Mr. McBride is survived by his wife and two children.

THE 200-INCH REFLECTOR AS IT LOOKS TODAY

News from the 200 inch disc! Here is a late picture of the giant reflector in its workshop. The rough grinding has been completed and the polishing is under way. The balance of the polishing and the figuring of the mirror will take the rest of this year and probably most of 1941, according to advices from Dr. J. A. Anderson, California Institute of Technology.

FROM THEORY TO PRACTICE AT HARTFORD-EMPIRE

By means of recently enlarged facilities the Hartford-Empire Company expands its broad studies in the technology and manufacture of glass, ranging from fundamental research to actual manufacturing.

The average person is apt to believe that to introduce a new device one has only to invent it. In reality, an invention as originally conceived, however important it may be, is seldom in a form that can be put into successful operation, and to make any invention practically workable usually requires quite a long period of time and a vast reserve of patience and persistence, not to mention the outlay of money.

In the case of automatic glass working machinery, the leading laboratory for the development of new ideas—and above all for the development of the idea into practical, workable form—is that of the Hartford-Empire Company, at Hartford, Conn. Here, under one roof, is gathered together what is perhaps the greatest assemblage of engineering talent, data and research facilities of which the glass industry can boast. The present discussion will give the reader some concept of this tremendously productive hive of research activity, which has been so successful in perfecting the means and methods for forming glass.

The story goes back a number of years. From the very first, Hartford-Empire has had to do an immense amount of testing and trial work under conditions as nearly as possible approaching commercial use in a glass factory. This was formerly done by testing the device on a small scale at Hartford and then putting the device or process into a commercial glass factory where it was operated first by Hartford engineers and later by the employees of the factory. In many cases Hartford hired space in a factory and reimbursed the licensee for glass and other expense involved in these experiments. In some instances, these costs were partly borne by the licensee. In both cases, however, in order to test an invention under commercial conditions, it was necessary for the Hartford people to go to plants located many miles from Hartford and, in many instances it was necessary to work under adverse conditions, owing to the differences in requirements for experimental and commercial operation. Furthermore, the remote location made it impossible for all of the engineers engaged in the particular development to continuously observe the operation. In some cases, valuable experience was lost and, therefore, in 1930 it was considered desirable to build an experimental glass factory in Hartford. This Experimental Plant proved to be of very great value. As time went on, however, the company also found the amount of research and preliminary development work increasing beyond the capacity of its available space. The Experimental Plant was therefore improved and enlarged to provide ample facilities for all phases of the development program. The new facilities were completed in the summer of 1939—and Fig. 1 shows the building as it appears today. The main office of the company and its machine shop and kiln building does not show in this picture.

Recently the editors of THE GLASS INDUSTRY were privileged to inspect the new Experimental Plant and to survey the various research and development activities for the information of its readers. Before going into the details of the story, however, a general understanding of the scope and organization of the work is necessary.

Although, as stated before, one of the Hartford-Empire Company's chief activities as a manufacturer and licensor of commercial glass machinery is the reduction of inventions to practical form, other phases of research and development are no less important and include an immense amount of fundamental research in the technology of glass, refractories and glass melting. Then there is also the intermediate development stage in which a discovery or theory is further tried out on a larger scale than is possible in the laboratory. And finally, there are the requirements for the testing of materials, glassware, machinery parts and instruments.

The Research and Development Department of the Hartford-Empire Company has at its command completely integrated laboratory facilities for working in glass, glass melting, annealing, refractories and glass working machinery. This department is headed by Dr. John C. Hostetter, Director of Research, and Karl E. Peiler, Associate Director. Its activities include everything from theory to actual practice; its importance and potential benefit to the world of glass manufacturing could hardly be over-estimated.

Starting at the research end, the first laboratory to receive attention is known as the Department of Glass Technology, and a view in his laboratory is shown in Fig. 2. This group carries on careful testing for the ac-

Fig. 1. Experimental Plant and Laboratories of Hartford-Empire Company at Hartfordd, Connecticut. The left part of the building houses the experimental glass plant, the cullet elevator and storage bin appearing at the rear; the one-story center portion houses the glass technology laboratories, the lehr department, etc.; the right side of the building is given over to the additional laboratories.

Fig. 2. A view in the research laboratory devoted to work on chemical technology and glass properties.

Fig. 3. Analytical chemical laboratory.

curate determination of glass properties, such as, viscosity, and is constantly searching for new data on the effects of varied chemical constituents.

On the second floor at one end of the building are located offices, the Analytical, Ceramic, Polariscopic and Petrographic Laboratories, and a completely equipped photographic dark-room.

A view in the Analytical Chemical Laboratory appears in Fig. 3. Its work includes the chemical analysis of glasses, refractories, raw materials, or other substances as needed. Determinations of chemical durability are also made here. Much of this activity is concerned with direct service to the Company's licensees. New methods for routine and also precision analysis of glass have been developed in this laboratory.

Another important research center is the Ceramic Laboratory shown in Fig. 4. Its objectives are the solutions of fundamental problems in the manufacture and use of refractories, including special requirements for Hartford-Empire equipment and also those for general use. Petrographic studies of "stones" in glass, and of refractories,

Fig. 4. In the Ceramic Laboratory petrographic studies of "stones" in glass, and of refractories, are important features of the work.

are an important feature of the work of this laboratory, and of great value to the licensees.

The Polariscope Room is a most interesting place and is furnished with some outstanding apparatus. The large polariscope is shown in Fig. 5 and is noteworthy for its base construction as well as for its instrumental details. The housing for the light source appears at the left hand end of the apparatus, the light passing through a condenser system and a pair of 6 inch Polaroid disks which act as polarizer and analyzer respectively. The specimen to be examined is mounted between the disks, immersed in a glass tank containing monochlorbenzene. A lens system is so arranged that the image of the specimen can either be photographed, as indicated in the illustration, or projected on the nearby wall screen.

Using this equipment, the degree of homogeneity of the glass in an article is readily studied. Moreover, the annealing of bottle walls may be seen or photographed without cutting the glass and the strains present in heavier pieces of press ware, such as insulators, may be investigated. A particularly interesting application lies in the measurement of strains caused by applied loads. Bottles may be loaded locally to stimulate impact hazards encountered in use, or they may be subjected to hydrostatic pressure such as would be caused by filling with beer or ginger ale. In this way the effects of shape, bottom thickness, etc., on strains produced in the glass may be studied. This is the same type of test as is widely used in the design of steel structures, airplane bracing, and machine parts, to reduce weight while maintaining necessary strength. The tests is of special advantage in the study of light weight glass containers. It is hoped that with its aid a considerable reduction in bottle weights and increased strength may be effected.

Another interesting and important instrument in this room is the extremely accurate polarimeter shown in Fig. 6. This device is one of the two most accurate instruments in existence for measuring strain in glass, the other being the apparatus built by Goranson & Adams at the Geophysical Laboratory of the Carnegie Institution at Washington. The scale on the analyzer of the Geophysical instrument permits closer work, but it is possible to measure path difference to 0.3 millimicron with this one. The detailed construction of this fine piece of apparatus and its use in the preparation of G.C.A. Annealing-Standard Disks by Hartford-Empire is a story in itself.

Fig. 5. The big polariscope utilizes 6-in Polaroid disks as polarizer and analyzer. The image of the specimen can either be photographed, as shown, or projected on the wall chart at the right.

Passing on from the laboratory phase of the research and development program, the next activity is in the field of intermediate development. Into this category falls the testing and trials of processes and materials on a larger scale than is possible in the research laboratory, but not under commercial conditions. This phase of development is important because it allows Hartford-Empire scientists and engineers to judge the worth of a new idea without going to the full expense of a thorough test under commercial plant conditions. If the new process or material still looks good in these tests, the commercial test can be made, otherwise it may be discarded without further expense.

Since practically all tests on glasses and refractories require the application of heat, the large room devoted to this stage of development work is furnished with a great variety of furnaces and kilns. A view in this room is shown in Fig. 7 and illustrates the type of equipment. From right to left can be seen a 36-in. x 42-in. kiln, a furnace for testing refractories, and a 12-in. x 18-in. glass tank. Altogether there are more than a dozen pieces of similar equipment, making it possible to carry on a great variety of tests on special glasses and refractories.

Having been conceived in the mind of a Hartford-Empire engineer or scientist, given thorough study and consideration in the research laboratory and tried on intermediate development apparatus, the new glass, refrac-

Fig. 6. One of the most accurate polarimeters in existence, similar to the Goranson & Adams instrument at the Geophysical Laboratory.

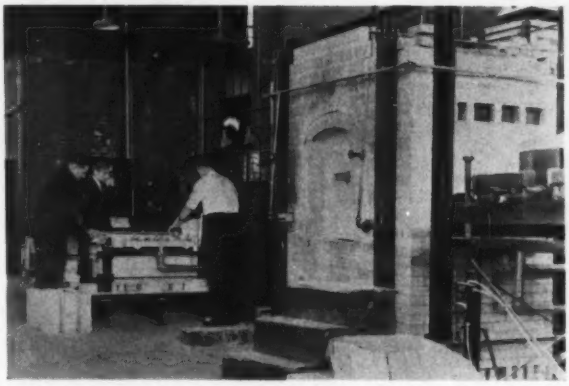
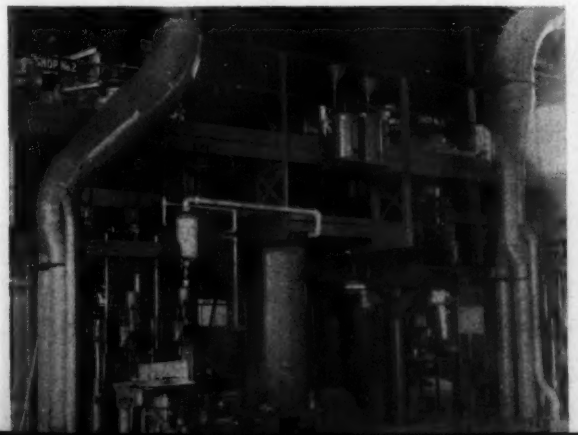


Fig. 7. Intermediate development department, containing more than a dozen kilns and furnaces. The three shown here are (from right to left) a 36 x 42-in. kiln, a contamination furnace (with observers), and a 12 x 18-in. glass tank.

Fig. 8. A view in the glass plant showing Shops No. 1 and No. 2. The upper platform passes in front of the glass feeders, two of which can be seen. Forming machines in process of development are located on the factory floor. Melting tanks are located between far ends of forehearths.

Fig. 9. Another view in the glass plant, showing machines and feeders at Shops No. 2 and No. 3.



tory or machine is ready for its final testing under conditions simulating those in an actual commercial glass plant. The Hartford-Empire experimental glass factory is quite amazing in its completeness, including, as it does, practically every glass plant function. Here is found commercially sized equipment for batch preparation, transport and charging; melting; feeding; forming and annealing.

Originally the experimental plant had a large continuous tank, but this did not provide sufficient flexibility for the complexities of experimental operation and the melting equipment was rearranged to consist of two special types of intermittent tanks with reserve space for two more. Plans are being made to add a third and fourth tank. The charging floor of the original furnace remains at one end of the building as a raised platform, on which are located most of the meters and recording instruments. The two special tanks are arranged to deliver glass selectively to three forehearths, each equipped

Fig. 10. A corner of the batch preparation room in the basement of the glass plant building, showing the scales and the mixer.

Fig. 11. The firing end of one of the day tanks for melting glass, showing the arrangement of piping for the two diagonal oil burners and the combustion air supply.

with a standard Hartford-Empire Single Feeder always kept to latest type. In this way an exact duplication of the conditions with a continuous tank are obtained in the forehearth and feeder. The tanks with their feeders and the forming machines are arranged along the south side of the building, Figs. 8 and 9 being views of this equipment from the factory floor. The shop-number signs on the upper railing are located near the discharging ends of the three feeders. The tanks can not be seen in these views, but they are located between and above the far ends of the forehearths. One tank discharges into forehearths No. 1 or No. 2, the other into No. 2 or No. 3. Each tank produces glass on alternate days and glass is thus available for two of the three shops each day.

Equipment and materials for batch preparation are located in the basement of the building. as shown in Fig. 10. Here can be seen the Toledo platform scales and the Chain-Belt mixer, the mixer being arranged to discharge into a batch bucket for transportation to the tanks. The bucket is lifted by a hoist through a hole in the floor to a tram-rail suspended beneath the roof of the building, the tramrail passing over the loading positions of two mechanical batch chargers located at the tanks between the forehearths. After the bucket load of batch has been dumped into the mechanical charger, the charger is moved a short distance to the front end of the tank and feeds the batch into the tank at the desired rate.

Fig. 13. A view toward the side of one of the tanks. The water-cooled damper appears at the extreme upper left and the valve mechanism for the glass discharge orifice at the lower left (through the railing).

Fig. 12. A draft gauge and the damper control are located on the wall at the rear of each tank. The windows look into the intermediate development department.

The metal line in the tanks is about 15 ft. above the factory floor and each tank has a melting capacity of about five tons of glass. Oil is used for fuel and the tanks are fired from the back end, that is, the end toward the wall of the building. Fig. 11 is a view of the burner and combustion air piping on one of the tanks showing the angular arrangement of the two burners which can be distinguished by their light-colored paint. All firing adjustments are manual. The temperature recording instruments are located on the platform in another part of the building, but a draft gauge is mounted on the wall behind each tank, as shown in Fig. 12, and the damper-operating handwheel is near by.

A side view of one of the tanks appears in Fig. 13, but the steel work makes such a maze that it is difficult to identify details. However, one end of the water-cooled damper can be seen in the extreme top left corner beneath the hood and flue leading to the stack. In the lower left corner, through the diagonal railing, can be distinguished the top end of the needle valve mechanism by which the flow of glass through an orifice from the tank to No. 3 forehearth is controlled.

In Fig. 14 you are looking down on the forehearth leading to Shop No. 1. The view was taken from the platform near the back end of the tank through the steel work supporting other platforms and runways. This steelwork interferes with photography, but the walkways and platforms are nicely arranged to give quick and easy access to all parts of the tanks, forehearth and feeders. The 14-ft. forehearths are standard in every way and are mounted so that the metal line is 12 ft. above the factory floor. Standard Hartford-Empire Single Feeders are installed on each forehearth. The forming machines are new designs in process of development.

Cullet from feeders and forming machines is discharged into a pan conveyor in the basement and subjected to a water spray. This conveyor passes along beneath the three shop positions, as shown in Fig. 15, the water-cooled cullet being delivered to another inclined conveyor at the far end, and finally to an elevator leading to a crusher and storage bin. From the storage bin the crushed cullet can be delivered back to the basement through chutes as needed for batch preparation.

The exceptional flexibility and varied test conditions provided by the combination of equipment in the Experimental Plant is immediately apparent. Refractories for

Fig. 14. This view through platform and walkway steelwork shows the forehearth leading to No. 1 shop.

tanks, forehearth and feeders can be given practical working tests of any desired duration; new kinds of glasses can be tried out in commercial quantities and their behaviour can be determined in all parts of the production line from the melting tank to the finished ware; and finally, new ideas in the design and construction of feeders, forming machines, moulds, lehrs and ware handling equipment can be thoroughly tested out at commercial speeds and with any desired kind of glass. Finished ware, in a great variety of types and sizes, is, of course, produced in semi-commercial quantities and is passed along to the annealing department where it becomes the raw material for practical development work in the removal of strain.

The annealing department is furnished with two standard Hartford-Empire Lehrs, both of which are fired with city gas and arranged for wide variations in belt speed and temperature gradient. One of these is a small 12-in. decorating lehr, 48 ft. long, and is shown in Fig. 16. It is used for various kinds of decorating operations and also for reannealing, with a proper change in the temperature gradient. The other lehr is a standard Type L, 44 in. wide. Fig. 17 shows the discharge end of this lehr, together with some of the ware manufactured and annealed in the Experimental Plant. With these lehrs available for practical testing, it can be seen that the Hartford-Empire Company has facilities for annealing research and development all the way from laboratories, with polariscope, polarimeter and special heating furnaces, to operation simulating that of a commercial glass factory.

As a check on forming and annealing operations, both in the Experimental Plant and in plants of Hartford-Empire licensees, an important part of the Hartford plant is the Ware Testing and Service Laboratory. With the latest types of testing equipment, this group examines all kinds of finished containers by means of ring sections, hot-and-cold and pressure tests. The laboratory has an enviable record in the maintenance of high quality in containers made on Hartford-Empire machines. Another important activity is the testing and maintenance of temperature instruments by which all such instruments, used by field men and others, are kept continually in proper repair and accurately calibrated.

Fig. 15. Hot cullet from above is deposited on this pan conveyor and sprayed with water. At the far end this conveyor discharges into a second one leading to the elevator.

The special machine shown in Fig. 18 is set up on the factory floor in front of the melting tanks. It was built solely for testing feeder refractories under conditions similar to those in actual plant operation. This work includes control tests on standard tubes and other expendable feeder parts and development work on new refractory materials or designs. Fig. 19 is a view in the well-equipped mold maintenance shop.

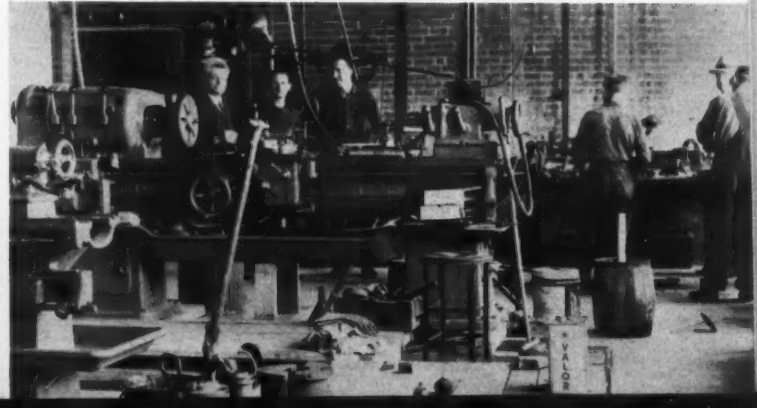
A visit to the newly enlarged Experimental Plant establishes in the mind of the visitor an entirely new conception of the wide differences between the original idea behind a patented process and its practical realization in commercial use. It also leaves no doubt of the comprehensive and thorough manner in which this company is meeting these problems in the practical application of science and invention to the improvement of modern glass working practice.

Fig. 16. This 12-in. standard decorating lehr is 48-ft. long and is used for reannealing as well as decorating tests.

Fig. 18. This special testing machine was built expressly for control and development testing on feeder refractories.

Fig. 17. The larger lehr in the annealing department is 44-in. wide and 60-ft. long. This shows the discharge end.

Fig. 19. This view shows some of the equipment and personnel in the well-equipped machine shop.



HEAT FLOW CALCULATIONS

The heat generated by the combustion of the fuel in a glass furnace is transmitted to the glass, to the surrounding walls (directly from the flame gases and indirectly from the glass) and to the stack. Heat balances made on various glass furnaces (Table 1) show that from 40 to 65 per cent of the fuel input is required to take care of the radiation and convection losses from the walls of the furnace. By the means of heat flow calculations these radiation and convection heat losses from the furnace walls can be determined. The same mathematical procedures that are used for such calculations can also be used for other furnace and refractory problems of interest to the glass plant engineer.

TABLE I

	Tank No.			
	1	*2*	*3*	*4*
Efficiency	10.0	19.1	11.5	8.9
Radiation and Convection Loss	61.0	62.6	44.0	52.0
Stack Loss	29.5	18.3	38.4	35.7
Fuel Gas Used	Coke Oven	Natural	Producer	Producer

When a glass furnace is in operation, the flame in the furnace gives up part of its heat to the inside wall surfaces. Where the wall surface is in contact with the glass, such surfaces receive heat from the glass. In the case of that part of the wall heated by the flame gases, the temperature of the interior wall surface depends upon the flame temperature, the nature and thickness of the flame, the pressure conditions within the furnace, the velocity of the flame gases and other such factors. In the case of that part of the interior surface of the wall that is in direct contact with the glass, the temperature of the interior wall surface depends mainly upon the temperature of the glass and the velocity of movement of the glass in contact with the wall. In both cases the heat so received by the interior wall surface is transmitted, through the means of conduction, from the interior wall surface to the exterior wall surface.

At the outside surface of the wall a definite temperature of equilibrium becomes established, its magnitude depending upon the interior wall surface temperature, the veocity and temperatures of the air in contact with this exterior wall surface, the nature of this surface and the thermal conductivity of the material used for the wall. As the outside surface of the wall is normally at a higher temperature than the surrounding air, there will be a definite flow of heat from the surface of the wall to the air. This flow of heat takes place mainly by by convection and radiation.

The discussion so far has been concerned only with the simple mechanics of heat flow through a furnace wall. The various heat flow calculations depend, however, upon the development of suitable mathematical expressions. In the case of heat flow by radiation from the surface of the wall to the surroundings it is known that such flow takes place in accordance with the laws developed by Kirchhoff and by Stefan-Boltzman. Thus the quantity of heat flowing by radiation from a unit area of surface at a temperature T_1 per unit of time to a surrounding absorbing medium at a temperature T_2 can be calculated from the following:

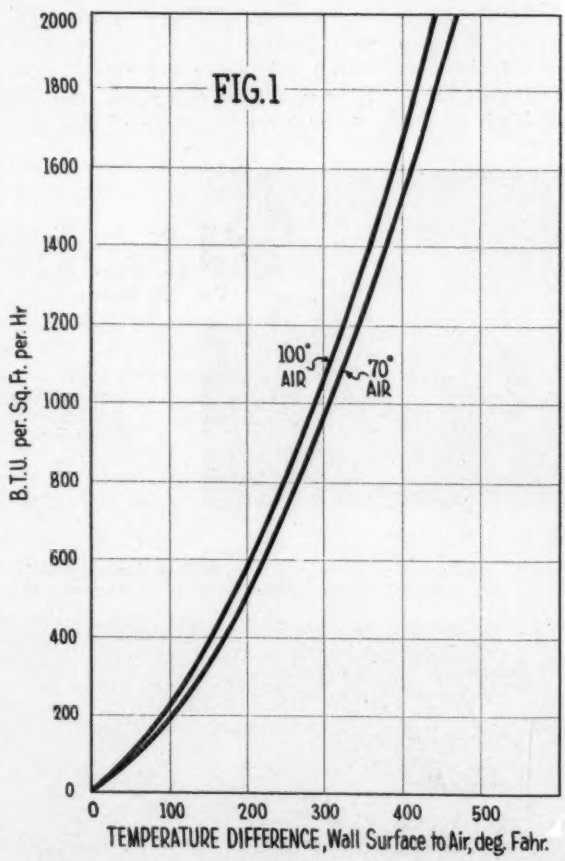
Equation 1. $Qr = Kr \times e \ (T_1^4 - T_2^4)$

where Qr denotes B. T. U. per hour per square foot, e being the emissivity of the surface or the absorbing power of the wall surface to black body radiation, the value usually being about 0.95 for wall surfaces such as rough steel or brick. T_1 is the temperature of the outer surface in degrees Fahrenheit Absolute (deg. Fahr. + 460), T_2 is the temperature of the surroundings in degrees Fahrenheit Absolute (deg. Fahr. + 460) and K r is the total radiation constant expressed in B. T. U. per square foot per hour from a surface at 1°F absolute to a medium at 0°F absolute. The value of K r has been determined by numerous investigators and the present accepted value is 17.4×10^{-10}.

Several different formulas have been developed for determining the heat flow from large surfaces by free or natural convection. Trinks has used the following relation[2]:

Equation 2. $Qv = 0.25 \ (T_1 - T_2)^{5/4}$

where Q v denotes the quantity of heat in B. T. U. flowing per square foot per hour, T_1 is the temperature of the wall surface in degrees Fahrenheit and T_2 is the temperature of the surrounding air in degrees Fahrenheit. As this formula does not take into account the shape of the



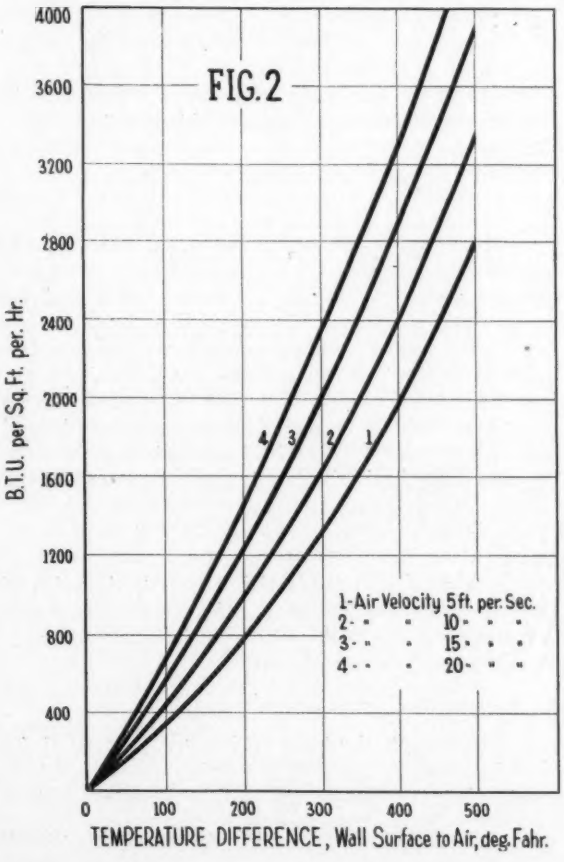
surface, additional accuracy can be gained by using:

$$\text{Equation 3.} \quad Qv = 0.53C\left(\frac{1}{Tavg.}\right)^{0.18} dt^{1.27}$$

where Q v denotes the quantity of heat in B. T. U. per hour per square foot, C is a constant depending upon the shape of the surface (in the case of a vertical wall the value of C is 1.39 while for a crown of a furnace its value is 1.79), T avg. is the average of the wall surface and the surrounding air temperature in degrees Fahrenheit absolute (deg. Fahr. + 460) and dt is the difference in temperature between the wall surface and the surrounding air in degrees Fahrenheit.

By combining the radiation heat flow equation with one of the convection heat flow equations the resulting expression makes possible the computation for various air temperatures the total heat flow per hour per square foot from a wall surface as a function of the temperature of the wall surface. Fig. 1 was obtained by combining equation 1 with equation 3, assuming a vertical wall condition and an e value of 0.95. Calculations were made using various temperature differences between the wall surface and the surrounding air at air temperatures of 70 and 100°F. The two curves given in Fig. 1 are the result of these calculations.

Equation 3 is only applicable in the case where the air surrounding the wall surface is not in rapid movement. In glass furnace practice it is often necessary to make heat flow calculations on walls which are being cooled with fan air. Such methods of cooling results in forced convection at the wall surface.



While considerable experimental work has been conducted on the loss of heat by forced convection from the surfaces of cylindrical bodies there is little available data on the loss of heat by forced convection from large plane surfaces such as furnace walls. At present the most used formula[4] for expressing the heat flow under these conditions is:

$$\text{Equation 4.} \quad Qfv = 1 + 0.225V$$

where Qfv is the B. T. U. per hour per square foot per degree Fahrenheit and V is the velocity of the cooling air in feet per second. By combining this equation with equation 1 and assuming an "e" value of 0.95 and an air temperature of 70°F the heat loss by radiation and convection for various cooling air velocities may be calculated. The curves given in Fig. 2 show the radiation and convection heat loss for various wall temperatures and for air velocities of 5, 10, 15 and 20 feet per second.

It is obvious that the same quantity of heat which flows per hour per square foot from the wall surface and is then lost through radiation and convection to the surrounding air and other objects must also pass in the same time per square foot through the wall from its higher temperature surface to the lower temperature surface. Here the heat flow takes place by conduction. In the case of a glass furnace at operating temperature the heat flow through the wall is in one direction only and in most cases can be regarded as independent of time. The flow of heat by conduction under linear and steady conditions is given by the relation:

$$\text{Equation 5.} \quad Qc = \frac{K\,(T_1 - T_2)}{L}$$

where Qc is the heat flow by conduction in B. T. U. per square foot per hour, K is the coefficient of thermal conductivity of the material used in the wall, T_1 is the inner wall temperature in degrees Fahrenheit, T_2 is the outside wall temperature in degrees Fahrenheit and L is the thickness of the wall in inches.

As the heat flow as given by the combined radiation and convection loss equations and the conduction equation is identical for a given set of conditions their use in connection with each other will allow several different types of heat flow calculations to be made. For example, in the case of a flux block located in a glass furnace wall, if both the inside and outside surface temperatures of the block can be measured it will then be possible to compute the approximate value of K, the thermal conductivity coefficient of the block material. Such a calculation is often desirable when several different types of block material are used in the furnace wall. Likewise if the temperature of the outer surface of the block and the thermal conductivity of the block material are known, the inner surface temperature of the block may be determined by simple arithmetic. The calculation of the inner surface temperature of the block allows an approximation of the glass temperature at this point to be made. The reverse is also true, if the temperature of the inner surface of the block and its thermal conductivity are known, the outside surface temperature of the block can be calculated. Such a calculation is helpful when designing a furnace that is to operate at known inside temperatures and it is necessary to know what temperatures might be expected at the outside surface of the walls.

By the use of these heat flow relationships it is also

possible to calculate the thickness of the flux and other blocks during the furnace run. For such a calculation it is necessary to know not only the thermal conductivity of the block but also the inside and outside surface temperatures of the block in question. Block thickness determinations are extremely useful in the prediction and discovery of thin spots in the furnace walls. Other data that can be obtained by these heat flow relationships include, for example, the determination of the value of insulation, the wall thickness required to keep heat losses down to prescribed values, and the determination of the temperature at the junction of a block and its insulation.

It can readily be seen that many of these calculations are impossible to perform unless the thermal conductivity of the materials used in the furnace walls are known. Scattered through the technical literature on refractories are numerous results of conductivity measurements of various refractory materials. A tabulation of the various results will show considerable variation on materials of the same type. Recent cooperative investigations by refractory research workers seems to indicate that these excessive variations are due in the main to the methods of measurement used by the different investigators. At present, therefore, the published values of thermal conductivity of refractory materials are so divergent that the best that can be done is to assume mean values from large groups of results. Typical values for fireclay, silica, fused alumina brick, and insulation materials are given in Figs. 3 and 4. It must be noted that these values do not represent any one particular brand of brick but are only values representative of the materials.

The practical use of these various heat flow calculations can be best illustrated by the following examples:

1. Calculation of the Inside Block Surface Temerature

Assume a outside surface temperature of 400°F at the face of a 12 inch block. In case A there is no artificial cooling of the block while in case B the block is being force cooled with air at a velocity of 5 feet per second. In both cases the air temperature is 70°F. A inside surface temperature of 2250°F is then selected for the purpose of performing the first trial calculation. As the thermal conductivity of the block varies with the temperature the mean temperature of the block must be determined. In this case it would be

$$\frac{2250+400}{2}=1325°\text{F}.$$

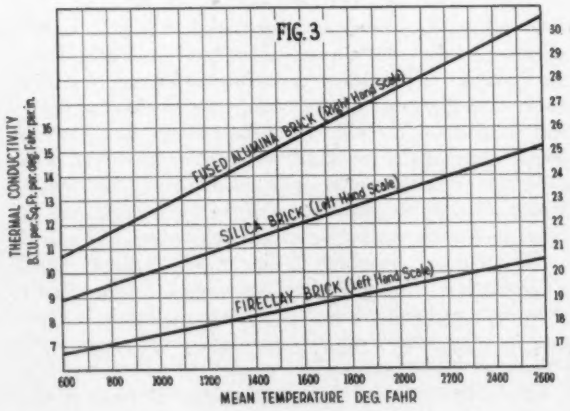
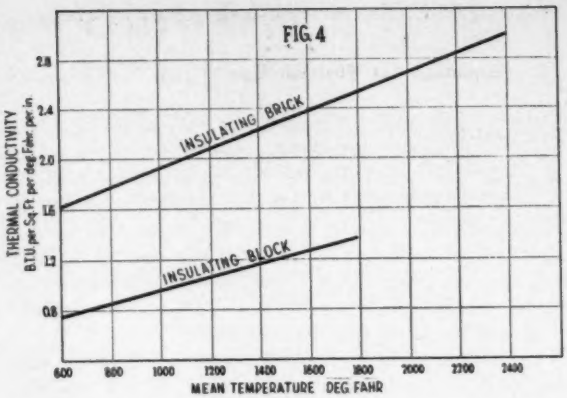


FIG. 3
THERMAL CONDUCTIVITY
B.T.U. per Sq. Ft. per deg. Fahr. per in.
FUSED ALUMINA BRICK (Right Hand Scale)
SILICA BRICK (Left Hand Scale)
FIRECLAY BRICK (Left Hand Scale)
MEAN TEMPERATURE DEG. FAHR



From Fig. 3 it is found that the thermal conductivity of fireclay for this mean temperature is 8.1. There is now sufficient data for the *first* trial calculation of equation 5, substituting in the equation we have,

$$Qc=\frac{8.1\ (2250-400)}{12}=1250\text{ B. T. U.}$$

From Fig. 1 we find that a block at a outside temperature of 400°F (temperature difference, 400-70 = 330°F) is giving up 1125 B. T. U. for case A and 1500 B. T. U. for case B (Fig. 2). The assumed value of 2250°F for the inside surface temperature is therefore too high for case A and too low for case B. For case A a new and lower value for the inside surface temperature is now assumed, say for example, 2125°F. The mean temperature will now be:

$$\frac{2125+400}{2}=1262°\text{F}.$$ From Fig. 3 the thermal conductivity for this mean temperature is found to be very nearly 8.0 Again substituting this data in equation 5 we get:

$$Qc=\frac{8\ (2125-400)}{12}=1152\text{ B. T. U.}$$

This new value of 1152 agrees fairly well with the 1125 figure found from the curve. The last inner surface temperature used, namely 2125°F, may be close enough for practical work, the error of course will be diminished by again recalculating with a slightly lower inner surface temperature figure. Turning to case B a higher inner surface temperature, namely 2500°F, is now assumed. Again the mean temperature and the corresponding thermal conductivity value is determined. For this case the value becomes 8.35. Again the data is recalculated as follows:

$$Qc=\frac{8.35\ (2500-400)}{12}=1461\text{ B. T. U.}$$

This value of 1461 is also fairly close to the value of 1500 obtained from the curve. The assumed inner surface temperature is still a trifle low, however, and a recalculation will decrease the error.

2. Calculation of Block Thickness

In this example the inner surface temperature of the block is assumed to be 2600°F and the outer surface temperature is assumed to be 500°F. The mean temperature

(*Continued on page* 250)

INVENTIONS AND INVENTORS

Summary of United States patents of interest to the glass industry issued during March

Compositions

Edwin Berger of Jena, Germany, received a patent on heat absorbing glass compositions, of which the following are typical:

	A	*B*
P_2O_5	53.0	53.5
SiO_2	27.0	27.0
Al_2O_3	13.0	13.0
CaO	0.4	0.4
BaO	0.6	0.6
Sb_2O_3	6.0	—
PbO	—	5.0
AS_2O_3	—	0.5
Fe	1.3	1.3

This patent 2,194,784 was assigned to Jenaer Glaswerk Schott & Gen. at Jena. The new glasses are said to be especially suitable for spectacle use, since the method of preparation reduces permeability to ultra-violet rays without affecting permeability to visible rays. Mr. Berger also holds patent 1,961,603 for glasses of a similar character.

Forming & Shaping

Thomas F. Pearson, the highly prolific inventor of glass machinery, of Pontefract, England, received another machine patent (2,193,376) which he assigned to the Crown Cork & Seal Co. In a forming machine for bottles or like ware in which glass charges are dropped into a number of molds in sequence for blowing, this invention provides means for guiding the charges and closing the molds during their rotation about the axis of the molding table.

The Capstan Glass Company of Connellsville, Pa., received through assignment, John W. Errett's patent 2,192,302 for improvements in automatic bottle machines. The principal object was to overcome the costly collisions between the rotating table and the pressing devices, occurring due to the failure of the air pressure which operates the latter devices. (The table is usually driven separately.) The invention provides various safety devices for swinging the obstructing units out of the way when there is a power stoppage.

Miscellaneous Processes

Details of a lens grinding and polishing machine were patented by William A. Lockhart of Waterloo, N. Y., and assigned to the Shuron Optical Co., Inc. (2,192,486).

Glass-to-metal seals were patented by Friedrich H. A. Brandt of New York City (2,192,892), and by Louis Navias of Schenectady (2,193,640). The latter patent was assigned to General Electric Co.

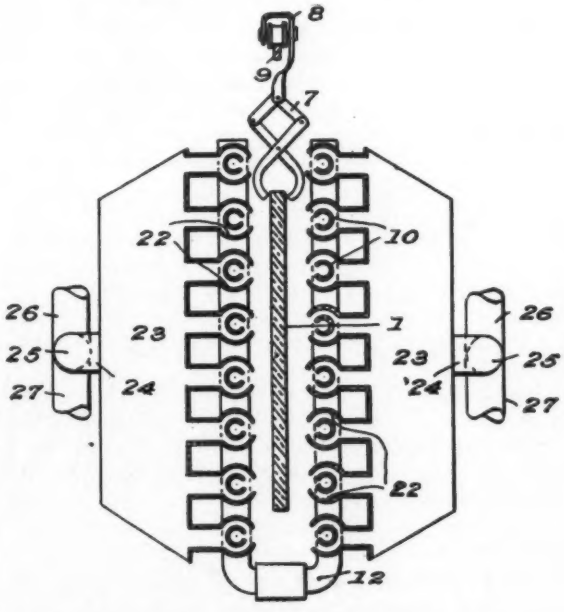
Wilbur R. Ferguson of Columbus, Ohio, obtained a one claim patent, 2,194,115, relating to the decoration of glass articles with vinyl resins. Such colors are applied at relatively low temperatures (for example 400 deg. F.) as compared with the much higher temperatures necessary to mature ceramic colors.

Patent 2,193,942 to Orie Shackelford of Fairmont, W. Va., is a bottle conveying apparatus which receives the bottles in the neck down position from the forming machine, conveys them without distortion, turns them upright, and feeds to a lehr stacker. Distortion is avoided by supporting the bottles on their sides and continuously rotating them to change their points of support.

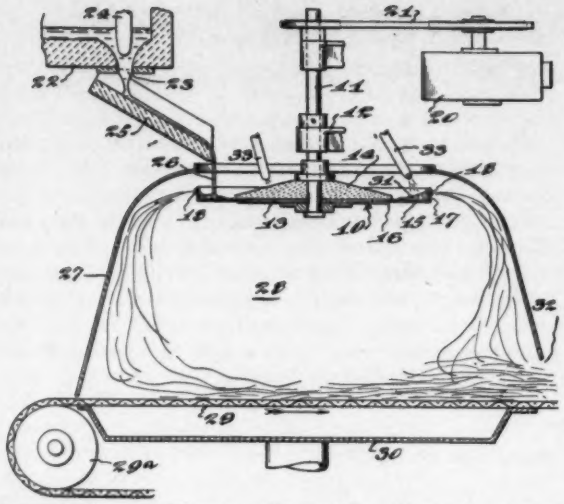
Paul Weathers of Audubon, N. J. (Radio Corp. of America), obtained a patent on modifications of the type of bottle-inspecting device which utilizes a light beam and a photoelectric cell. It is applied primarily to fluted bottles, such as those used for Coco-Cola, and provides an optical system which gives a light beam focused into a narrow line at the interior surface of the bottle. This is patent 2,192,568.

Plate and Sheet Glass

The international character of development work on tempered glass sheets is evidenced by the issuance during March of U. S. patents in this field to workers in England, France, and the United States. John Wilson of Birmingham, England, and Bernard Long of Paris, assigned patents 2,194,730 and 2,194,760 to the American Securit Co. of Wilmington. The third patent was 2,194,612, granted to Ormond H. Paddock, and added by assignment to the important group of Libbey-Owens-Ford patents on tempered sheets. Wilson's invention provides that the heating, preparatory to chilling, be accomplished by immersing the glass article in a molten metallic bath, having a melting point below the strain point of the glass (for example a bismuth alloy), and heating the bath to near the softening point of the glass. The Long patent, illustrated in Fig. 1, proposes to eliminate the cooling of tempering glass sheets, which occurs while they are being transported from the heating chamber to



2,194,76: Long. In tempering glass sheets the blowers 22, are alternated with burners 10, so chilling may be accomplished at top heat without conveying the sheet to a separate chamber.



2,192,944: J. H. Thomas. Glass fibers, formed by being thrown from the spinner 10, are accumulated on a conveyor.

the chilling chamber. The improvement includes apparatus in which heating and chilling are carried out in the same chamber. The nozzles for distributing cooling air are arranged alternately with the burners. Mr. Paddock's patent 2,194,612 provides apparatus for heating sheets in successive stages in a tunnel-type furnace for tempering. One feature is the provision of sheet carriers whose shape is such as to allow them to cooperate to substantially close the open top of the furnace.

Mr. Paddock also collaborated with Arthur McK. Greaves-Walker in the invention of novel decorating procedures (2,194,611, to Libbey-Owens-Ford). In applying these methods to tempered glass sheets, a colored vitrifiable material is applied to one surface of the sheet and matured in the tempering heat treatment. The color composition is so chosen as to have essentially the same expansion coefficient as the glass sheet, and in general to have no effect on the breaking characteristics of the glass.

Patent 2,194,570 for an apparatus for cutting and flattening plastic sheeting, was assigned to Libbey-Owens-Ford Glass Co. by the inventors, Conrad B. Schafer and John L. Drake, of Toledo.

Carl J. Malm of Rochester, assigned to Eastman Kodak Co., his patent 2,192,196 for laminated safety glass. It is stated that exceptional resistance to shattering at abnormally high and abnormally low temperatures is obtained by the use of a layer of a high-viscosity cellulose organic acid ester containing a high percentage of plasticizers.

Improvement in safety glass was also claimed by Brook J. Dennison of Aspinwall, Pa., in patent 2,194,013 assigned to Pittsburgh Plate Glass Co. His invention provides a new class of plasticizers to be used with the plastic composition.

Glass Blocks

Edward J. Winship of Baltimore assigned his patent 2,194,731 to Corning Glass Works. A hollow glass block is made of two halves which instead of being fused together, are merely clipped together by metal clamps, applied to flanges.

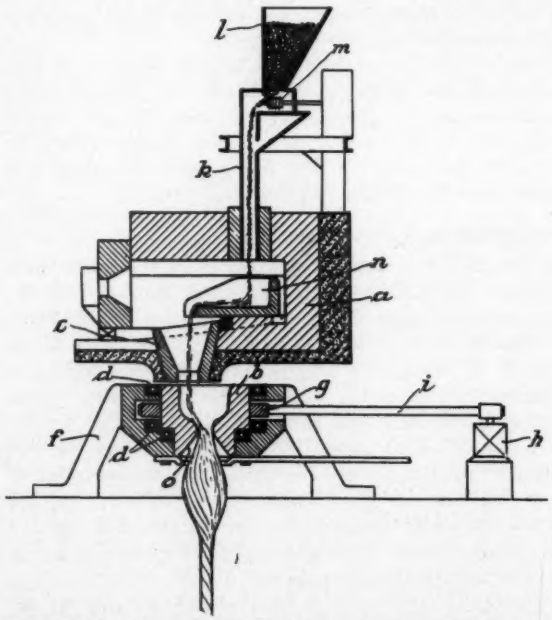
The two patents granted to Raymond W. Kell of Charleroi for glass blocks and manufacturing methods, may be considered as a group with the two H. H. Blau patents issued in February. All four patents were assigned to Corning Glass Works. Mr. Kell's patent 2,194,755 describes methods and apparatus for forming complemental halves which are fused together by a special technique involving, first, heating the seam on two opposite sides, and then on the other sides. Patent 2,194,756 contains claims directed to a block with a continuously convex abnormally heavy burr of glass along the joint on the inside of the block.

Glass Wool and Fiber

March saw more activity in the field of glass fiber patents than has developed since this department of *Glass Industry* was inaugurated. Nine fiber patents were issued.

Patents 2,194,727 to L. S. Vello of Saint Cloud, France, and 2,194,728 to Lambert von Reis of Herzogenrath, Germany, were assigned to Naamlooze Vennootschap Maatschappij tot Beheer en Exploitatie van Octrooien, The Hague, Netherlands. The fiber-forming method covered by the latter patent consists in discharging a stream of glass into a hollow cylindrical vessel, tapered at the bottom, which is rotated fast enough to divide the stream into fine fibers which are twisted together by gravity and centrifugal force as they leave the vessel to form a fiber rope or cord. This is illustrated by Fig. 2. The Vello patent applies improvements to the method of forming glass fibers by delivering a thin stream of molten glass upon a high-speed rotating disk.

A spinner type of fiber-forming apparatus is also covered by 2,192,944 granted to John H. Thomas of Newark, Ohio, assignor to Owens-Corning Fiberglas Corp. As shown in Fig. 3, the spinner includes a platinum ring, upon which the molten glass flows and from which the



2,194,728: L. Von Reis. A glass stream flowing into the rapidly rotating vessel b, is said to form fibers which are twisted by centrifugal force into fiber rope or cord as they fall away.

fibers are thrown. The ring provides a certain reservoir capacity and may be heated by conductors extending downward through the spinner shaft. The fibers accumulate on a conveyor.

Patent 2,195,158, granted to Felix J. Watts of Detroit, provides means of depositing and compacting fibers on traveling belts.

The patent issued to E. B. Powell of Alexandria, Ind., and assigned to Johns-Manville (2,192,524) actually concerns the blowing of mineral wool. It is worth mentioning here because it is related to the art of making glass fibers. The earlier Powel patents constitute, commercially, perhaps the most important group of mineral wool patents.

Apparatus for making so-called interstitial aggregates of glass fiber for filtering and other uses, was patented by Andrew H. Stewart of Shields, Pa. His apparatus provides a drawing chamber extending from the tank floor level into the tank proper, and a number of openings for drawing a plurality of streams simultaneously (2,194,814).

Uses for glass fiber were dealt with in three patents. Patent 2,193,429 to Edmond S. McConnell of Ossining, N. Y., assigned to Anaconda Wire & Cable Co., covers a conducting cable made of metallic strands and a core of spun glass strands. Arthur D. Saborsky of Rossford, Ohio (Owens-Corning Fiberglas Corp.) was granted patent 2,192,933 dealing with insulated wall panels. Games Slayter and John H. Thomas of the same company patented the use of a glass wool blanket applied to a seed bed after sowing the seeds (2,192,939). This is an interesting corollary to the now important use of such blanketing for winter mulching.

Miscellaneous Uses & Products

Window construction details were patented by Roy T. Axe of Syracuse, New York (2,193,852 and 2,193,853, assigned to the O. M. Edwards Co., Inc.), and by Harry J. Bader, Troy, Ohio, who assigned his patent 2,194,109 to the Troy Sunshade Co.

Patent 2,193,393 to Edward Danner of Newark, Ohio, is a heat-insulating glass panel comprised of two sheets spaced apart by a wire reinforced glass strip or strand to which they are fused.

GAMES SLAYTER TO RECEIVE HIGH HONOR

Games Slayter, vice-president of the Owens-Corning Fiberglas Corporation, is to receive an outstanding honor from the Franklin Institute for his development of Fiberglas, on May 15.

The award, an Edward Longstreth Medal, will be presented during the annual Medal Day exercises of the Franklin Institute, and is given, "in recognition of meritorious work in science and industrial arts."

The Institute has previously awarded four medals to scientists in the glass field. In 1915, the Elliot Cresson Medal to Michael J. Owens for his bottle machine; in 1921, the Longstreth Medal to Drs. L. H. Adams and E. D. Williamson for their work on the annealing of glass; in 1926, the Howard N. Potts Medal to Eugene C. Sullivan and William C. Taylor for their work on the composition of super-resistant glasses; in 1937, the Potts Medal to Dr. J. C. Hostetter for his contributions to the technology of glass.

ARMSTRONG BUILDING AT MILLVILLE

The Forter-Teichmann Company has been retained as engineers and architect for a new building unit, 180 feet wide by 200 feet long, to be built for the Armstrong Cork Company at their Whitall-Tatum Division, Millville, N. J. The company has also been awarded the contract for the construction of two complete new oil-fired glass tank furnaces. The new tanks are to be practically identical to the tank built last year by the Forter-Teichmann Co.

CLEARS FLAT GLASS INDUSTRY

On April 17, representatives of the Department of Justice concluded an investigation of the flat glass industry in the Pittsburgh area. This was part of a larger survey following complaints of unfair marketing and other practices alleged to be in violation of the anti-trust laws. A dispatch from Pittsburgh dated April 17 quotes Mr. M. Neil Andrews, special assistant to the attorney general, as stating at the conclusion of the Pittsburgh investigation, "that no case of conspiracy to restrain trade had been uncovered in the industry and that no evidence had been presented to a Federal grand jury."

DR. SILVERMAN DENIES SPONSORSHIP

EDITOR, *The Glass Industry*:

A Works Progress Administration report entitled "Glass Manufacture: A Bibliography of Pertinent Articles and Other Literature Issued in 1937", published by the Carnegie Institute of Technology, indicate that I was sponsor of the project during the first year. I wish to make clear that I am in no wise responsible for the publication, as I did not see it until it was published.

Alexander Silverman.

R. F. SHERWOOD NOW VICE PRESIDENT

Robert F. Sherwood was recently elected vice president of the United Feldspar and Minerals Corporation and president of the Carolina Pyrophyllite Company, succeeding the late Charles Pederick. Mr. Sherwood has been associated with United Feldspar for the last five years.

A. A. HOUGHTON, JR., NAMED CURATOR

Arthur A. Houghton, Jr., president of Steuben Glass, Inc., and vice-president of the Corning Glass Works, has been appointed curator of the rare book collection of the Library of Congress.

Mr. Houghton is the possessor of one of this country's outstanding rare book collections. Among the Houghton treasures are such important items as the works of Keats, Spenser, and Lewis Carroll. It contains original letters and manuscripts of Samuel Pepys, Robert and Elizabeth Browning, as well as the original manuscript of Boswell's Life of Johnson, and many other rare items. Mr. Houghton is a director of the Hartford-Empire Company, the Empire Machine Co. and of the Lackawanna Railroad.

BULLETIN ON NEPHELINE SYENITE

The Engineering Experiment Station of the Ohio State University has recently published an interesting bulletin titled "Nepheline Syenite in Ceramic Wares" by Dr. C. J. Koenig. A brief history of the material is discussed with the early results. The bulletin covers the present-day uses of "Lakefield" Nepheline Syenite in the ceramic industry, including a chapter on glass. The investigation was in cooperation with the Great Lakes Foundry Sand Company and the American Nepheline Corporation.

CURRENT STATISTICAL POSITION OF GLASS

Activity in the glass industry during March picked up considerably. Production increased, exports were unusually large, and imports recovered somewhat from February's low point. Employment and payrolls followed the upward trend.

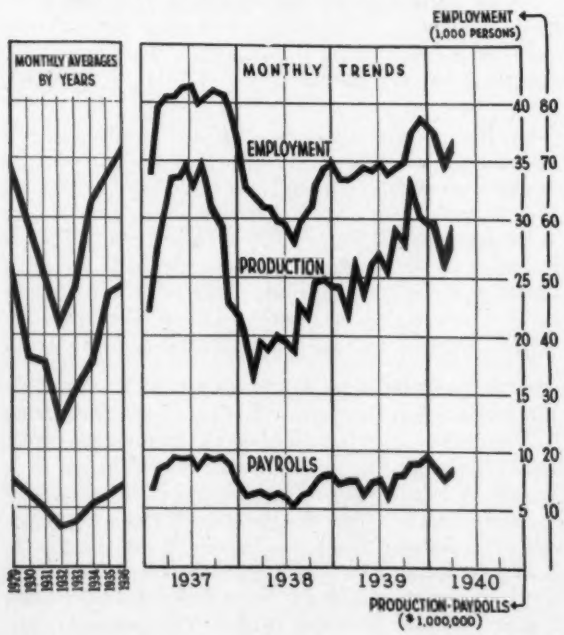
According to GLASS INDUSTRY's Production Index, glass output during March was valued at about $29,500,000. This was an increase of 9 per cent over the previous month and 12 per cent more than March 1939. Production during the first three months of 1940 is estimated at over $86,500,000, or more than 15 per cent above last year's level.

Plate Glass: Production totalled 14,302,978 square feet during March according to the Plate Glass Manufacturers Association. This represented increases of 9 per cent over the previous month and 20 per cent over March of last year. During the first quarter of 1940 production exceeded 44,734,000 square feet which was 30 per cent greater than last years comparable figure and within 7 per cent of this industry's record first quarter (1936).

Window Glass: Output during March amounted to 1,107,437 boxes which was a slight increase (less than 1 per cent) over February's total but exceeded March of last year by 21 per cent. First quarter totals indicate that 1940 activity in the window glass industry is running about 36 per cent ahead of 1939. During the first three months of this year, production exceeded 3,620,000 boxes, the largest on record, (monthly statistics for the window glass industry were first published for January 1937).

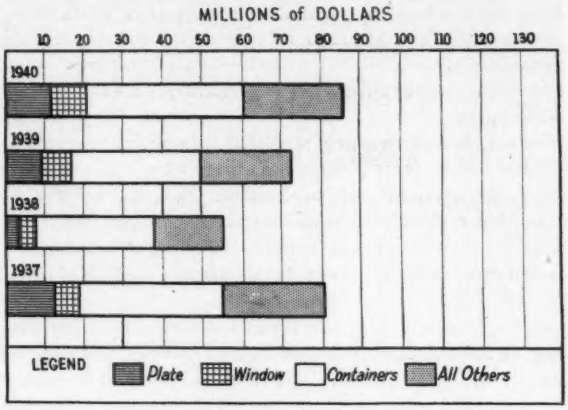
GI THE GLASS INDUSTRY'S INDEX

Monthly Trends Through March, 1940



GI THE GLASS INDUSTRY'S INDEX

Production for the month of March



Glass Container: Production during March totalled 4,606,388 gross according to the Glass Container Association. This was a 12 per cent increase over both the previous month and March of last year. A new first quarter record was set by this industry with production approximating 13,000,000 gross—17 per cent more than 1939's first quarter and 7 per cent above the previous record (1937). Container shipments during March increased 10 per cent over February's volume to 4,230,821 gross, which was also higher (by 8 per cent) than in March 1939, However, stocks on hand continued to soar, hitting the all-time peak of 10,078,387 gross. Shipments during the first three months of 1940 were 10 per cent ahead of last year but dropped 3 per cent below 1937's comparable figure.

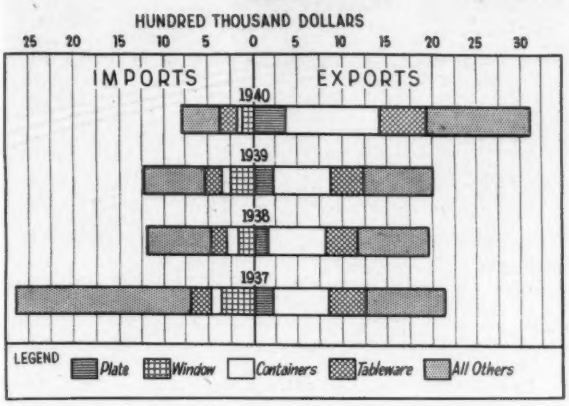
Miscellaneous Glass Products: Manufactured during March were valued at approximately $9,000,000 according to reliable estimates. This was an increase of 6 per cent over February and represents about the same percentage gain over March of last year. Activity in the illuminating ware branch ran about 5 per cent ahead of these comparable months; only slight improvement was noted in tableware plants. During the first quarter of 1940 production of miscellaneous glass products was about 13 per cent ahead of last year.

Employment and Payrolls: About 74,000 persons were employed in the glass industry during March which was an increase of 2,500 over the previous month. This compares favorably with March 1939 also, when employment was estimated at 67,300.

Payrolls in the glass industry during March were valued at about $8,300,000—5 per cent above February's figure. This represented an increase of almost $1,000,000 over March of last year. During the first quarter of 1940, glass manufacturers paid out close to $25,000,000 in wages as compared to $22,000,000 in last year's comparable period.

THE GLASS INDUSTRY'S INDEX

Foreign Trade for Three Months, January to March



Foreign Trade: Exports of glass and glass products during March were valued at $1,101,000—a 15 per cent increase over February and 40 per cent more than March of last year. All lines of ware shared in this increased trade. Largest percentage gains were registered in window glass and illuminating glassware sales, while sizeable volume increases were reported for containers and tableware. Foreign sales of American glass during the first quarter of 1940 were greater than in any recent comparable period. The preliminary total for these months was $3,124,000 which represents a 54 per cent increase over 1939 figures. On this year-to-year basis, window glass increased 400 per cent, illuminating ware 120 per cent, and plate glass 65 per cent. Exports of containers alone exceeded $1,065,000, 66 per cent ahead of last year.

Imports of glass during March recorded an increase of 49 per cent over February, or $318,000. However, they were 37 per cent below March 1939 levels. Larger purchases of Swedish tableware were responsible for the gains in that line; plate glass also was purchased in greater amounts. Combined figures for the January-March period reveal an import trade of $767,000 which was 38 per cent below 1939's comparable figure. Sharp declines in window glass, containers, and illuminating ware accounted for a good part of this trend.

RECENT FOREIGN TRADE OPPORTUNITIES

Reference Number	*Commodity*	*City and Country*	*Purchase or Agency*
6776	Bottles for pomades and pharmaceuticals; wines and liquors	San Jose, Costa Rica	Agency
6822	Bottles for mineral water	Maracay, Spain	Purchase
6801	Glass for building construction	Alexandria	Both
6792	Glass containers for candy	Kitchener, Canada	Purchase
6808	Glassware	Alexandria	Both
6820	Pressed tumblers and iridescent glassware	Manila, P. I.	Agency
6909	Glass bricks	Rio de Janeiro	Both
6882	Glass lamps	London	Purchase
6984	Pharmaceutical bottles	Cairo	Agency
6974	Fancy toilet containers	Alexandria	Both
6952	Window glass	Cairo	Agency
6947	Glassware	Bogota, Colombia	Purchase
6985	Pharmaceutical bottles	Colombo, Ceylon	Purchase
6977	Fancy toilet containers	Caracas	Agency
6873	Window glass	Cairo	Agency
6952	Glassware	Cairo	Agency

SPECIAL SUMMER COURSES AT M.I.T.

A summer program of technical conferences and courses on research and practice on the frontiers of science and engineering has been announced by Professor Raymond D. Douglas, chairman of the summer session, at the Massachusetts Institute of Technology. This program, which supplements the regular summer courses for undergraduate and graduate students, will include four important conferences and thirteen special advanced courses. These are planned primarily to meet the requirements of graduate engineers who wish to be brought up to date in the scientific and technical background of their professions.

Two conferences of special interest to the ceramic industry will be the Eighth International Conference on Spectroscopy under Dr. G. R. Harrison, and a summer conference under Professor F. H. Norton on Ceramics.

UNITED STATES FOREIGN TRADE IN GLASS
(Values in Thousands of Dollars)

	1940			*1939*		*Percentage Change*		
	March	*February*	*Three Months*	*March*	*Three Months*	*Feb.-Mar.*	*Mar.-Mar.*	*Three Months*
EXPORTS								
Plate	92	78	366	75	222	+ 18	+ 23	+ 65
Window	26	13	50	3	10	+100	+767	+400
Containers	380	346	1065	254	641	+ 10	+ 50	+ 66
Tableware	198	185	510	155	373	+ 7	+ 28	+ 37
Illuminating Ware	55	52	231	35	105	+ 5	+ 57	+120
All Other	350	287	902	267	672	+ 22	+ 31	+ 34
Total	1101	961	3124	789	2023	+ 15	+ 40	+ 54
IMPORTS								
Plate	24	6	54	10	18	+300	+140	+200
Window	60	23	120	98	251	+161	— 39	— 52
Containers	18	11	45	47	98	+ 64	— 62	— 56
Tableware	92	48	187	97	195	+ 92	— 5	— 4
Illuminating Ware	8	6	19	50	131	+ 33	— 84	— 85
All Other	116	120	342	203	542	— 3	— 43	— 37
Total	318	214	767	505	1235	+ 49	— 37	— 38

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	45.00	51.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027 -.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054 -.0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar— (list prices)			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00-31.00	....
In bags	ton	31.60-32.60	42.00-45.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.076	....
In 5 Ton lots	lb.	....	.08
Less than 5 Tons	lb.	....	.085
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	8.50	8.50
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.00-14.00	....
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00-20.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate (A1 $(OH)_3$)	lb.	.026-.029	.03½
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.14	.14½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.06¾-.07	.07½-.07¾
Tin Oxide (SnO_2) in bbls	lb.	....	.51
Titanium Oxide (ceramic grade)			
In bags	lb.	.12	.12¼-.12½
In barrels	lb.	.12¼	.12½-.13
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¾	.06½
White Seal, 150 lb. bbls	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled 01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.00-1.05
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	40.00	44.50
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_3O_4)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.165
Black (CuO)	lb.	....	.18-.19
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425-.09
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls	lb.	....	.135
Manganese, Black Oxide			
In Paper bags	ton	62.50	65.50
In Burlap bags	ton	64.25	67.25
In Casks	ton	66.50	69.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09¼-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.19-.24
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08⅜-.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	2.00-2.05
Yellow	lb.	....	2.00-2.05
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	3.05-3.10
Yellow orange	lb.	....	2.00-2.05

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.04
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	....	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

The 4-Star Formula

• In the manufacture of glass the popular formula today is Soda —Lime—Silica, plus Borax. The addition of this "fourth" ingredient is the modern way of making better glass more economically.

• Though a minor ingredient in the glass batch Borax is of major importance—for it is a very powerful fluxing agent. It greatly assists in the refining process and imparts remarkably improved qualities to glass. The finished product is stronger and has better clarity and brilliance.

• With Borax you bring about quicker melting at lower temperatures and consequently get longer life out of refractory linings. Borax definitely cuts down on fuel costs. It will save you money and enable you to put out a better product.

PACIFIC COAST BORAX COMPANY
DEPARTMENT G • 51 MADISON AVENUE • NEW YORK

EQUIPMENT AND SUPPLIES

OFFERS NEW LEHR BELT

For use with its "Firoll" type of glass annealing lehr, the Toledo Engineering Co., Toledo, Ohio, has recently introduced a new style of lehr conveyor belting, known as the "Panweld" type. The "Panweld" belt is composed of a multiplicity of welded sheet-steel units, or pans, linked together with transverse steel pins and providing a glass-carrying surface that is absolutely flat.

As shown in the accompanying illustration, the "Panweld" belt unit is made of 16-gauge sheet steel, pressed and welded into a sturdy, box-type section that resists warpage and distortion. Each unit has an overall length of 5½ inches, the pitch of the assembled chain being 5 inches. The width of the "Panweld" unit is 4 inches, so that lehr belts can be assembled in any width that is a multiple of 4 inches.

In a finished belt each one of the outer series of "Panweld" units has a steel angle welded to its upper face near the outer edge. The row of angles prevents the hot glassware from slipping over the side of the belt and coming into contact with the tunnel lining.

For driving, a special sprocket is used, the sprocket having properly spaced spuds, or teeth, that fit into the recesses in the under sides of the "Panweld" units. At the discharge end of the lehr the belt passes directly over the driving sprocket, no other driving rollers or idlers being required at this point. Grooved idler rollers carry the belt at the loading end.

In spite of the relatively heavy sheet-steel from which the "Panweld" units are formed, the manufacturer states that the completed belt weighs only 6.45 lb. per sq. ft. The new belt, therefore, is able to keep down lehr heat losses, as well as to combat loss of otherwise good ware by marking or checking.

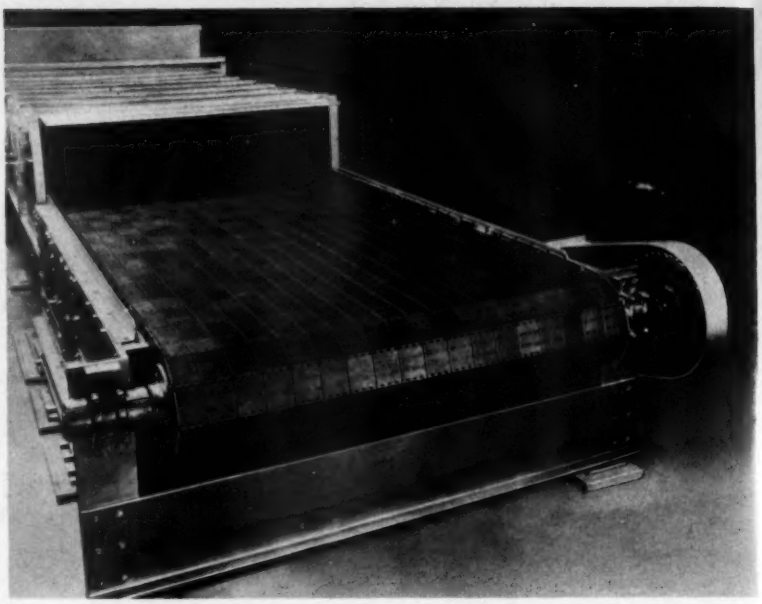
DECAL DECORATING

"Preliminary tests conducted by Hartford-Empire show that colored decoration applied to glassware by decalcomania made by lithographic means can be fired commercially in continuous decorating lehrs.

Tests on firing cycles were made with a Hartford-Empire decorating lehr of a type now operating in the glass industry. In general, only a slight adjustment to such lehrs is required.

Information on the lehr equipment can be obtained from The Hartford-Empire Company. Information regarding glassware decoration by the decalcomania process can be obtained from Universal Ceramics Corporation, 205 West 19th Street, New York.

● The Fitch Recuperator Company announces the removal of their office to Room 304, Plainfield National Bank Building, Plainfield, New Jersey.



NEW PYRO MICRO-OPTICAL PYROMETER

The new PYRO MICRO-OPTICAL Pyrometer is used for measuring the temperatures of very small objects such as incandescent lamp filaments, and for laboratory and scientific research work. A twenty-fold magnification is provided by means of an optical arrangement of high candle power. To obtain the best results, it is furnished with a rigid support and tripod, the instrument holder being equipped with a fine precision worm gear arrangement for accurate adjustment, in any desired direction so as to focus on any given spot or on the smallest object. A precision ammeter with built-in battery is attached to the instrument. The instrument operates on the principle of disappearing filament and is furnished with the following scale ranges: 600-1600° C; 1600-3000° C; 3000-4000° C, or the equivalent in degrees F. A powerful objective of 37 mm. aperture produces a reversed image of the object to be measured at about 6″ (15 cm.) distance; it is viewed through the ocular which acts as a microscope. The total magnification of the system is about 20 diameters so that the image of the smallest wire or filament under observation will fill the optical field and completely cover the tip of the pyrometer filament image.

● The American Foundry Equipment Company announces the appointment of Mr. Friedrick Birschel, Jr. as representative in South America. He will have his headquarters at Gaspar Campos, 1550, Vicente Lopez, F. C. C. A., Argentina.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

General Electric Co., Schenectady, N. Y., three bulletins of interest to plant men. GEA-1184D, A-C Magnetic Motor-Starting Switch for Squirrel-cage Motors or as Primary Switch for Wound-rotor Motors. GEA-3301, Reactrol System for controlling electrically heated equipment; furnaces, boilers, superheaters and air heaters. GEA-2915A, general purpose Capacitor Motors for pumps and compressors, laboratory equipment and machine tools.

Metallizing Engineering Company, Inc., Long Island City, N. Y. Bulletin P-11 describes the new process of "Metcolizing" to resist heat corrosion. In addition to its use for Metcolozing, the Metallizing unit may be used for maintenance, production and corrosion problems in the plant.

FERRO BOOKLET

"The Finish on Your Product," a new publication of the Ferro Enamel Corporation, Cleveland, giving information on this subject from laboratory data. Eight finishes are compared on a chart giving the "pro and con" for each finish, and what the finish will stand in the line of treatment. It indicates the advantages of using porcelain enamel.

BOOK REVIEW

The Tools of the Chemist, by Ernest Child, Reinhold Publishing Corporation, New York, 1940. Price $3.50, 220 pp.

This little book is something rather out of the ordinary in the way of a history of science. As we all know, an advance in technique which usually involves an advance in apparatus is apt to be followed by substantial advances in scientific knowledge; but nonetheless, most scientific history is written in terms of a succession of abstract ideas or of the discoveries themselves without much reference to the mechanism that made the discoveries possible. Mr. Child's attitude is different.

Throughout the early part of American scientific history the apparatus tended largely to come from Europe. This condition was changing when the Great War of 1914 broke out and was vastly accelerated thereby. This book, therefore, is written from an American viewpoint, but with a clear concept of the European origins that dominated the situation until twenty-five years ago.

In Part II of the book, which extends from pages 75 to 172, the apparatus of the chemist is classified under the headings:

1. Balances
2. Glassware
3. Porcelain Ware
4. Silica Ware
5. Filter Paper
6. Heating Apparatus
7. Metal Laboratory Ware
8. Platinum
9. Alundum
10. Rubber Ware
11. Optical Apparatus

From the point of view of the glass industry a short article on glassware of some twenty pages giving something of the early history of the companies which are now known, or were recently known, as the Libbey Glass Company, Corning Glass Works, and Whitall Tatum, comes up for consideration. Necessarily, the information is rather sketchy and we may perhaps hope that some day someone will write a good history of the development of the glass industry on American soil.

We congratulate Mr. Child on his attitude towards the history of science and upon the work which is presented in this volume.

F. W. Preston

ILLUMINATING ENGINEERS RECOMMENDATIONS

The Illuminating Engineering Society has prepared and adopted a recently recommended practice for the illumination performance of residential ceiling luminaries. The purpose of the recommended practices is to assure the manufacture of lighting equipment which, when properly installed under the conditions for which it is intended, will render good service and contribute to eyesight conservation by providing effective illumination, reasonably well distributed, free from objectionable glare and disturbing contrasts.

Information regarding these new recommendations may be had by writing to the Illuminating Engineering Society, 18 East 41 Street, New York.

Want to borrow a LONG, GRAY BEARD?

Our technologists say it's very useful in solving production problems.

• If you go to our research laboratory in Washington, Pa., you'll find a group of highly skilled technologists surrounded by all the modern scientific equipment you can imagine.

They keep looking for facts about Drakenfeld colors and chemicals that will make your production easier, more economical. They have a keen scientific curiosity about new processes, new materials, new advancements in the glass industry.

But every once in a while a problem comes up that calls for something *more* than laboratory knowledge.

When that happens, they like to don the long, gray beard of experience we've grown during our seventy years of service to the industry. It represents a past that has been filled with rich, down-to-earth experience in the field. It represents the sort of Science that wears overalls and likes to see how things work out in actual production.

Have you a problem involving the use of colors or chemicals? Drakenfeld technologists can give you the latest findings of research—*backed up by practical experience and interpreted in terms of your own specific needs.* They'll be glad to help without obligation. Just write.

Acid, Alkali and Sulphide Resistant Colors and Enamels . Squeegee Oils and Mediums . Metallic Oxides and Chemicals . Gold, Silver, Platinum and Lustre Preparations . Supplies.

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are often the answer to poor quality glass

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The right type of product for your job. Solvay Alkalies are produced in various forms to meet specific manufacturing requirements. The Solvay Products Book will give you complete information on types and strengths of all Solvay Products.

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SOLVAY DUSTLESS DENSE SODA ASH
More than 99.80% Sodium Carbonate *(on a dry basis)*

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"GLASS CENTER" TO REOPEN

The Glass Center, which attracted close to 7,000,000 persons in the 1939 season is being made ready to open. All of the features that caused people to return to this building more frequently than to any other Fair exhibit, according to every tabulation and poll taken last year, will be retained for 1940 with numerous additions and innovations. In addition, a schedule of special entertainment events has been scheduled by Glass, Inc., the building and operating corporation.

Owens-Illinois Glass Company, Pittsburgh Plate Glass, and Corning Glass Works, the three building sponsors last season, have been joined by the Owens-Corning Fiberglas Corporation, the new and fourth sponsor.

On Wednesday May 1st the doors of the building were thrown open for a special press preview to about 150 editors, who were brought to the Fair from Manhattan in special motor coaches, and who at the conclusion of the tour of the building were entertained at a "glass luncheon" in which the napery and most of the tableware was of glass, provided by the various companies. The presidents of the four sponsoring glass companies also spoke briefly on the future of the industry, on new products ready for the market or in the laboratories. Robert L. Hamill, president of Glass, Inc., presided. Harvey D. Gibson, chairman of the board of the Fair, was a guest at the luncheon and preview.

Once again the glass blowers will keep the main rotunda of the Glass Center jammed with spectators, while to the right of their platform will be the display of the oldest American colonial relics—the pieces of glass, crucibles, pots, etc., flown from Jamestown, Virginia, where they were unearthed several years ago on the site where Capt. John Smith built the first glass factory in 1608. Jacqueline Cochrane, world's greatest aviatrix and noted cosmetiste, will fly the relics from Jamestown ceremonies to the Fair on May 14th. The discovery of these relics, and the authentic records of history proved definitely that the glass industry is the first and oldest in America, and that from the Jamestown factory the first manufactured goods ever exported were sent to England in 1608.

Another innovation which radically changed the appearance of the Glass Center is the installation of the "Crystal Gardens" and the "Singing Gardens" in the outdoor patio facing on the Avenue of Pioneers. Here, in place of the somewhat futuristic and wholly symoblic decor of last year, beautiful effects have been created by Skidmore, Owings & Merrill who have used a large amount of glass, shrubbery, fountains, pools and music to provide a restful and beautiful space for weary Fairgoers. Additional seating arrangements have been made in this patio and the laughing mirrors will still be in evidence to amuse visitors.

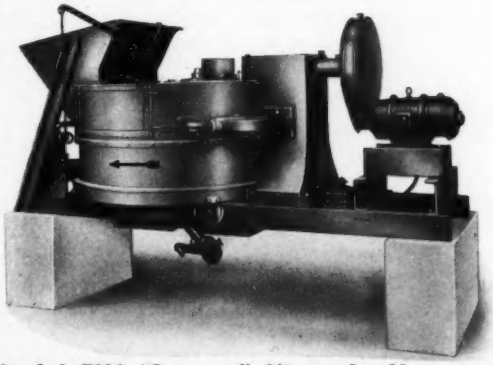
The building itself had to be extended to accommodate the additional space taken by the new sponsor, Owens-Corning Fiberglas, which will show all of the manufacturing features of last year, in addition to an extensive animated display showing the many uses of glass cloth in industry and the home.

The "Glass in the Home" section, which vividly portrayed the "home of tomorrow" with its glass curtains, tableware, fiberglas upholstery, etc., has been done over by Dan Cooper, noted interior architect and the most modern glass objects for the home will be shown there.

Lancaster
Counter
Current
Rapid Batch
Mixers

Don't Buy Just Another Mixer—

Buy "Lancaster"



Symbol EMG "Lancaster" Mixer, closed pan type with stationary hopper. Elevator hopper equipment also available.

THE "Lancaster" Mixer is not "just another mixer." It is a precision built machine tool, designed to perform a mixing job that is better than average; and built to provide long, dependable service under intensive operation schedules.

Glass Manufacturers are discovering in the "Lancaster" the kind of operating economy and scientific accuracy which has long been an objective for the batch house—shorter mixing time; uniformity between batches in order to obtain a more uniform melting rate; perfect development of predetermined formulas; easier cleaning facilities for quick change-over from one batch to another; and improved means for dust control.

Let us send a representative to outline the modern mixing efficiency of a "Lancaster" for your requirements. Write today.

LANCASTER IRON WORKS, INC.
BRICK MACHINERY DIVISION
LANCASTER, PENNA.

Due to the large crowds which the lampworker in the Corning-Steuben section attracted last season, his station has been placed in a new position and elevated so a maximum number of persons can watch his skilled fingers fashioning various objects of glass. Corning also has made a new arrangement whereby its commentators will be elevated and pass from section to section explaining each display object in detail.

So many prominent figures in the world of the stage, screen, radio, industry and government visited the Glass Center at the New York World's Fair last season—and so many invalided persons insisted on seeing the glass blowing show in the great mirrored-ceiling rotunda—that the officials of Glass, Inc. decided upon an innovation for the 1940 season. A special "Glass Box," elevated above the regular spectators' level, yet on an inclined runway which will permit wheel chairs to take the occupants directly into the box, has been built in the rotunda. To this box will be escorted such celebrities as visit the Glass Center, and also those invalids using wheel chairs in their Fair visit. The special noted guest book kept last year has the signatures of countless notables included on its pages.

Owens-Illinois also has changed its exhibit space materially, adding many new features dealing with the Libbey ware, modern glass containers, bottles, glass block and other products made by this company. Pittsburgh Plate likewise has added new features in home displays, store-fronts and other commercial use of carrara, block, art and other structural glass.

May 14th, the day the Jamestown relics arrive at the Fair, has been named Glass Center Day by the Fair authorities, and the week of June 24th, when the winning contestants in the Glass Center's Cinderella and the Glass Slipper contest come to the Fair from some 14 different cities in the east, has been officially designated as Glass Week at the Fair grounds. During that week the city Cinderellas will be judged to select the New York World's Fair Cinderella who will be crowned with elaborate coronation ceremonies on Thursday, June 28th, with the other girls taking the roles of Ladies of the Court. A Cinderella Ball is being staged by Michael Todd for the Glass Center Cinderellas the night of the coronation.

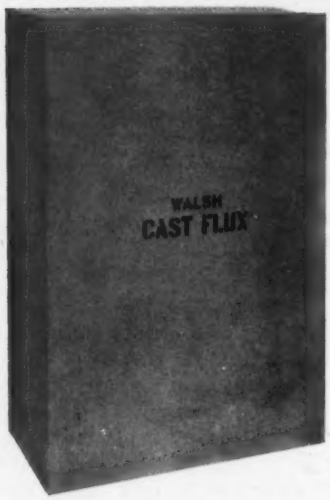
Also during June the winner of the annual National Marbles Tournament, conducted by about 200 newspapers all over the country, will come to the Glass Center as the guest of the glass companies, and with several of the other youthful marbles champions will give daily exhibitions in the Crystal Gardens of the building.

Arrangements have been made to conduct special tours of the building for the delegates to more than 300 leading industrial, civic and other organizations who are holding conventions during the time the Fair is opened.

CHARLEAS H. PEDDRICK, JR.

Charles H. Peddrick, Jr., vice president of the United Feldspar and Minerals Corporation and president of the Carolina Pyrophyllite Company, died unexpectedly on April 4 at his home in Northville, N. Y. He was 69 years old and had been active as a leader in the feldspar industry since 1922. Mr. Peddrick started his feldspar mining at Cranberry Creek, and introduced "chemically content" feldspar to the industry.

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street

St. Louis Missouri

HEAT FLOW CALCULATIONS

(*Continued from page* 238)

of the block is therefore 1550°F, which corresponds to a thermal conductivity of 8.55. The surrounding air temperature is again 70°F. From Fig. 1 (for the case of natural cooling) we find that the heat loss from a block having a surface temperature of 500°F (temperature difference, 500 — 70° = 430°F) is 1750 B. T. U. per square foot per hour. Substituting this data in equation 5 and solving for the block thickness we find:

$$1750 = \frac{8.55\ (2600 - 500)}{X},\ X = 12.6 \text{ inches}$$

Using the same surface temperatures for the case of a block being cooled with air at a velocity of 5 feet per second, Fig. 2 shows that a surface at a temperature of 500°F (temperature difference, 500 — 70 = 430°F) and at a air temperature of 70°F is losing 2220 B. T. U. per square foot per hour. Substituting the data and again solving for x we have:

$$2220 = \frac{8.55\ (2600 - 500)}{X},\ X = 8.0 \text{ inches}$$

As has been mentioned these heat flow calculations may also be used for determinations in which several different materials make up the wall thickness, for example, a wall consisting of firebrick, insulating material and red-brick. In this case the conductivity formula equation 5 becomes as follows:

Equation 6. $$Qc = \frac{T_1 - T_2}{\frac{L_1}{K_1} + \frac{L_2}{K_2} \ldots\ldots\ldots\ldots + \frac{L_n}{K_n}}$$

where Qc is again the quantity of heat conducted in B. T. U., per square foot per hour, T_1 is the temperature of the hotter surface in degrees Fahrenheit, T_2 is the temperature of the cooler surface in degrees Fahrenheit, $L_1, L_2 \ldots\ldots\ldots L_n$ is the thickness in inches of each course of material and $K, K_2 \ldots\ldots\ldots K_n$ is the thermal conductivity of each material. This type of calculation while somewhat more involved is performed in the same manner as those illustrated.

[1] W. Mullensiefen, *Glastech. Ber.*, 1929-30, 7, 188.
[2] A. E. Badger, V. C. Fugman, and H. I. Vormelker, *Glass Ind.*, 1935, 16, 5.
[3] W. Friedman, *Glastech. Ber.*, 1932, 10, 593.
[4] H. S. V. Gill, *Jour. Soc. Glass Tech.*, 1935, 19, 319.

ALTEN'S *Heat-Treated* PLUNGERS

DENSE STRUCTURE
READY MACHINABILITY
LONGER WEAR

ALTEN'S *Foundry and Machine Works*
LANCASTER OHIO

See Strains in Glass with the B&L POLARISCOPE

FREQUENTLY you can easily correct conditions that cause strain in your glass products through application of the information furnished by a B & L Polariscope. It makes it possible to actually *see* strains and to estimate degree of strain.

A new high intensity illuminating unit and improved optics adapt the B & L Polariscope to the most exacting work and make its possible to examine and check transparent, frosted or colored glass objects. A large operating and mechanical field permits inspection of large bodies up to 15″ diameter at a glance. No special skill is required in its operation.

The Ring Test Microscope

The B & L Ring Test Microscope reveals strain in cross sections in many cases where the Polariscope has shown no strain existed. To complete your inspection processes you need this valuable instrument. Complete details are available.

For further information on either of the above instruments, write to Bausch & Lomb Optical Co., 624 St. Paul St., Rochester, N. Y.

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. . . . WE MAKE OUR OWN GLASS TO INSURE STANDARDIZED PRODUCTION: FOR YOUR GLASSES INSIST ON B & L ORTHOGON LENSES AND B & L FRAMES . . . .

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THE USE OF AMERICAN FELTS IS TRUE ECONOMY

Leading manufacturers of glass rely on us to supply them with Polishing Felts which will give superior service and have longer, satisfactory life. Polishing costs less and goes along without hitches when American Quality Felt is used, because it has uniform density and increased absorption properties. Greater strength against strains and stresses of mounting felt on the polishing heads is another reason. Then, too, our Felt is put through a conditioning process which makes it ideal for beginning of the line and effects long life so that it performs satisfactorily at the important end of the line polishing.

You are cordially invited to discuss any problem regarding polishing or the use of natural Felt with our Technical and Research Staffs. Their knowledge of the properties and uses of Felt is being augmented daily through work in the field and continuous development and test work in the laboratory.

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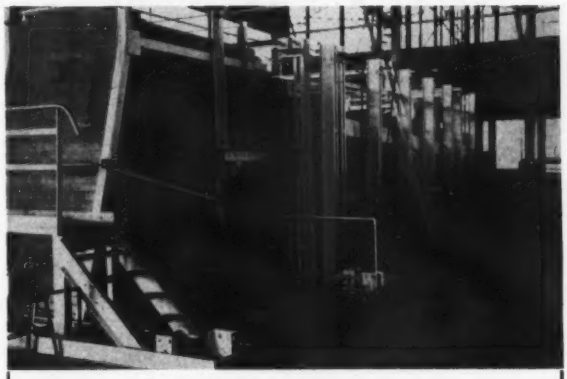
"A Felt for Every Purpose . . . A Standard for Every Felt"



FOR BETTER GLASS
AT
LOWER COST
INSTALL TANK FURNACES
USING
ANY FUEL
Designed and Built by
FORTER-TEICHMANN CO.
119 Federal Street Pittsburgh, Pa.
Cable Address "Forter"

Milk Blank Casting of Gunite C-CA

In actual production Gunite C-CA milk blank castings have given unusually long service before removal for polishing. They are made with any size chill desired . . . the valve is cored.

The high efficiency of these Gunite Castings is attested through complete customer satisfaction.

Gunite blanks and blow moulds are giving glassware produced on automatic machines a very high lustre. One manufacturer reports Gunite moulds give glass a lustre equally as high as chromium plated moulds.

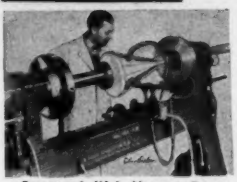
Write for full details.

GUNITE FOUNDRIES CORPORATION
Rockford, Illinois
Established 1854

SPECIAL GLASSWORKING MACHINES

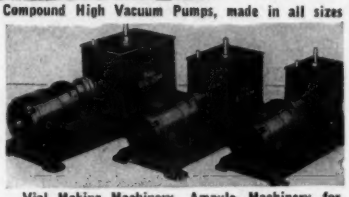
Blow Torches and Cross Fires of All Kinds

ELECTRONIC LABORATORY GLASS WORKING UNIT
Used in Schools, Colleges, Scientific Institutions and Experimental Laboratories
FOR MAKING
Incandescent Lamps, Radio Tubes, Electronic Tubes, Neon Tubes, Glass Work of all kinds —many types and sizes.



GLASS WORKING LATHES
Butt Sealing Lathe. Made in various types and sizes to meet your requirements.

Compound High Vacuum Pumps, made in all sizes



Vial Making Machinery for all types of vials

Ampule Machinery for any size or shape

EISLER ENGINEERING CO.
Chas. Eisler, Pres.
742 SO. 13 St. (near Avon Ave.), NEWARK, NEW JERSEY

COLORS that *Sell!*

• Colors from HOMMEL give extra attractiveness to your products —lend an unusual richness that SELLS. Hundreds of satisfied customers use eye appealing HOMMEL shades for finest results.

Transparent and Opaque—Enamels and Fluxes—Liquid Lustre Colors—Acid and Alkali Resistant—Ices—Squeegee Colors—Burnish Gold and Silver.

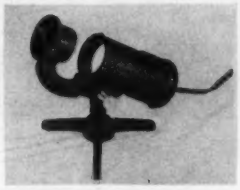
Complete line of Glassmakers Chemicals including Barium Carbonate—Borax—Cadmium Sulphide—Feldspar—Fluorspar—Manganese Dioxide—Potassium Bichromate—Soda Ash—Sodium Nitrate—Uranium Oxide.

THE O. HOMMEL COMPANY

209 FOURTH AVENUE, PITTSBURGH, PENNA.

Factory: CARNEGIE, PENNA. • New York Office: 200 WEST 34th ST.

Polaroid Strain Testing



THE PORTABLE

This compact portable glass inspection polariscope weighing less than two pounds offers the same high precision obtained in larger Polaroid Strain Testing Units. Works on 110 volts a.c. or d.c., 1" eye piece, 1¾" polarizing field. Tripod is removable so that polariscope can be carried in briefcase.

Especially adapted for examination of glass objects such as tubing up to 1" diameter or lenses and other flat areas up to 2 inches.

An indispensable utility instrument for

Sales executives
Service men
Laboratory work
Branch offices

Write for full details to

THE POLARIZING INSTRUMENT CO.
630 Fifth Ave. (Rockefeller Center) **New York City**

DESIGNS
MODELS
MOULDS
MOULD CASTINGS
Quality and Quick Service
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A GRACIOUS HOST FROM COAST TO COAST

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OPERATING YEAR AROUND

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS

FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

MIN-OX

The Binney Castings Company

Originators of Alloys for Glass Moulds

2555 Dorr Street Toledo, Ohio

GLASS SPECIALTIES

Transparent Colored Blown Sheet Glass
Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY" — the scientific illuminating glass.

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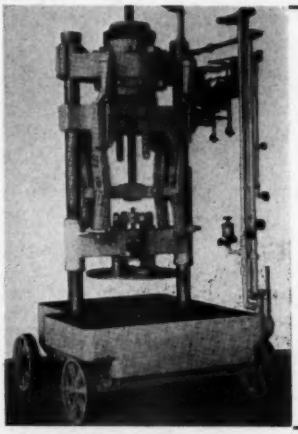
CONVEX GLASS CO.
Point Marion, Pennsylvania
New York Office: 110 West 40th St.
Chicago Office: 1597 Merchandise Mart
"IF IT'S MADE OF GLASS, ASK US FIRST"



NEW *One Mould* PRESS

For the production of a large variety of pressed ware

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GENERAL GLASS EQUIPMENT CO.
Atlantic County Trust Bldg.
ATLANTIC CITY, N.J.

Laclede-Christy

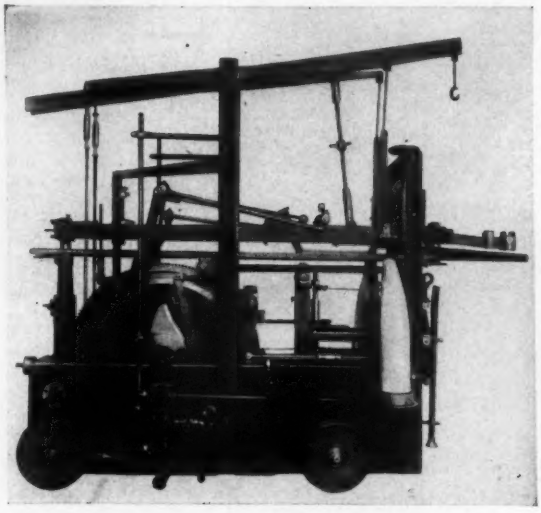
Clay Products Co., St. Louis, Mo.

Where the first test furnace was designed and built — the largest of its type exclusively for glass — a valuable adjunct to our Mellon Institute Fellowship in developing Tank Blocks of exceptional durability.

ROIRANT

SINGLE AND MULTI-MOULD MACHINES

Universally known for the production of small and large bottles



Type "F" single - mould suction machine for the production of small ware

Type "A6" twin table six-arm suction machine for the production of bottles

Also type "B" single-mould suction machine for bottles and type "BB2" suction machine for carboys up to a capacity of about 14 gallons

Any particulars from:

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7, rue Chaillet, Fribourg, Switzerland